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Nursery & Market Garden Industries'
- - Development Society, Limited. - -

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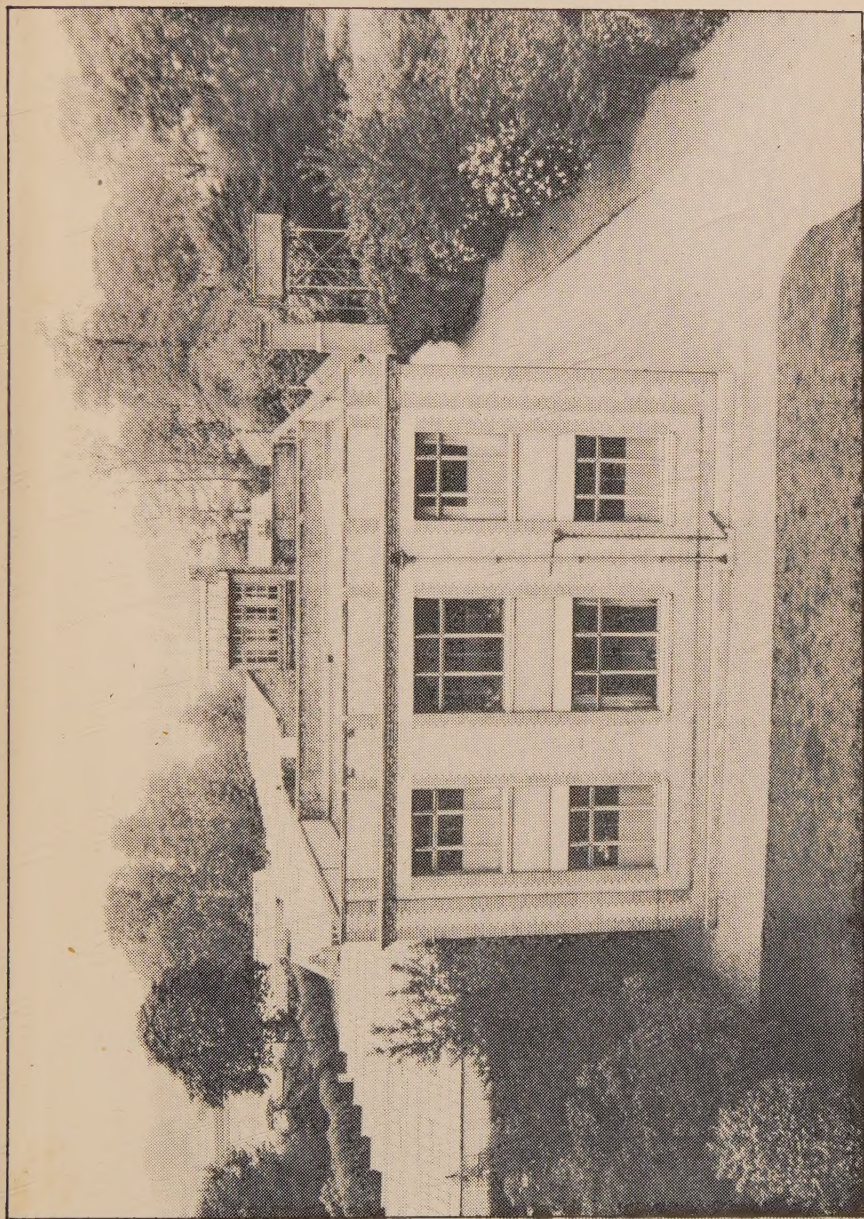


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Introduction.

THE year 1938 calls for no special comment, except for the European crisis from which the nursery industry suffered in common with every other industry. Trade was affected seriously and did not recover for several months. The growers themselves remained calm and confident in their determination to do their best for their country in face of changing circumstances.

From the crop standpoint 1938 proved to be an average season. The propagating period was one of the easiest in memory. The mild weather encouraged rapid growth and there were no serious troubles. The tomato crop grew rapidly from the day it was planted, for which the exceptionally warm month of March was largely responsible. The bottom trusses set well and no difficulty was experienced until the middle of April when the weather changed. From this time onwards, cool weather prevailed, the development of the fruit was retarded and picking was unduly slow. There was an absence of any real "glut" period and prices, though low, remained at a fairly steady level.

About the middle of the year many crops failed, through root injury. This was not unexpected, for it frequently occurs when the growth is abnormally rapid during the early stages and root development does not balance the growth of stem, leaves, and fruit. 1938 was a season in which sterilization paid handsomely for it enabled the roots to remain free from decay despite the variable weather conditions.

The end of the season was remarkable. Good weather prevailed, and where the root systems were healthy heavy top crops were harvested, picking in many cases continuing until the end of November.

The Clean Seed Association made little headway during 1938. The fund was not increased to any material extent, but the Committee decided to start work on a smaller scale than that intended originally. Search was made for a suitable site, and after some time arrangements were made to lease a field of 7.5 acres on a farm near Burgess Hill belonging to Mr. W. J. Bull.

The erection of eight tomato houses 100 feet long and 15 feet wide will be commenced early in 1939, and it is hoped that clean seeds will be available for distribution to shareholders towards the end of the year.

Members' Day.

Members' Day was held on Tuesday, 31st May. The visitors assembled in the Relph Hall, opposite the Research Station, at 11 a.m. for a short conference, when papers were read by the Director and Mr. W. H. Read. Lunch was served in the Halsey Masonic Hall at 1 p.m., and during the afternoon the laboratories and experimental houses were open for inspection. At the conclusion of the day tea was kindly provided by the President, Mr. C. H. Shoults.

Members' Day is invariably well attended. It is a popular annual event which enables growers to become acquainted with the work of the Station and to meet other growers from distant parts of the country.

Membership.

Membership of the Society, under whose auspices the experiments are conducted, is open to all growers and interested persons. Subscriptions are payable at the rate of two guineas for each acre of glass cultivated by the subscriber; in return members receive all publications and any advice which is available. Members continue to be enrolled, but many more are needed, both to provide additional funds for research and to obtain co-operation in controlling the various pests and diseases common to glasshouse plants. Serious outbreaks over a wide area must be fought by all growers; isolated attempts to control disease are almost bound to fail.

Endowment Fund.

An endowment fund has been opened to receive contributions from those who desire to further the work of the Station. The capital is invested in Trustees and the interest only will be used for (a) future development, and (b) repayment of debt.

It is hoped that those who can possibly contribute to this fund will do so, and so help to secure the Station's future prosperity.

Current Investigations.

The investigations with tomatoes was concerned with crop yield and quality of fruit as affected by root restriction, amount of water applied, and soil sterilization by chemical means.

The experiments with pots and cardboard containers were a continuation of previous trials. The main trials were conducted in houses 4 and 5, where the treatments were arranged in blocks of four. In the control plot the plants were planted in the ground, and in the other three plots they were planted in 10 in. clay pots, 8 in. $\times$ 8 in. $\times$ 8 in. cardboard containers and 6 in. $\times$ 6 in. $\times$ 6 in. cardboard containers respectively. The earliest pickings came from the clay pots and the latest from plants growing directly in the ground, those in cardboard boxes being between the two. The weight of crop was highest from the clay pots and from the larger cardboard containers, there being little difference between the two.

The smaller cardboard containers yielded a slightly lower crop and they were obviously too small. The lowest yield of all was given by the control plants growing in the ground. The results of three years' experiments shews that growers would be well advised to try these cardboard containers, because they have invariably provided heavier and earlier crops than were obtained by the normal method of planting in the ground.

An attempt was made in houses 2 and 3 to determine the effect of applying much less water to the soil during the season than is normally given. Unfortunately the

experiment had to be discontinued after the first six weeks because a severe attack of the root eelworm, *Heterodera marioni*, induced serious wilting, and it was necessary to apply the peat treatment to the surface of the soil, therefore watering in the usual manner became impossible.

Advantage was taken of the severe infestation of eelworm in the soil of houses 7 to 10, to test once again the effect of certain chemical sterilizers, and for this purpose a proprietary sterilizer at two different concentrations was compared with formaldehyde and cresylic acid. None of the treatments proved really effective and it became necessary to apply the peat treatment to the surface of the soil. Averaging the crop yield at the end of the season, shewed that the weight from the plots treated with formaldehyde and cresylic acid were almost identical and slightly higher than those from the plots treated with the proprietary sterilizer. It should be noted, however, that this sterilizer had given excellent results the previous year, when applied five weeks before planting the tomato crop. For the current experiment, the sterilizers were applied immediately after the previous crop had been removed, and the different effect produced this year may be due to the eelworms being protected within pieces of root at the time the sterilizers were applied.

The variety trials were devoted chiefly to testing a number of new crosses made in 1937. The best of these proved to be E.S.1 $\times$ Potentate $\times$ Kondine, Helvetia $\times$ E.S. 1, and Bides Recruit $\times$ Potentate $\times$ Ideal, but they were not outstanding. The cross which gave such promising results in 1936 and 1937 proved disappointing, and while this may be due to eelworm infection in the root, the work of selection must be continued before it can be released for general use.

The leaf mould resisting varieties, particularly No. 1 (Stirling Castle $\times$ E.S.1 $\times$ Radio), have given satisfaction in small trials on commercial nurseries, and will be tested more extensively in future.

The cucumber experiments were concerned with the composting of the beds, normal beds were compared with those to which clean wheat straw was added, and also with those in which the horse manure was replaced by wheat straw reinforced with dried blood. The results were not conclusive and the investigation will be continued.

Cheshunt Early Giant and Cheshunt Early Ball lettuce once more yielded good crops in the glasshouses and cold frames respectively. Cheshunt Early Giant is now well established throughout the country, but Cheshunt Early Ball deserves greater publicity for it is an excellent cold-frame lettuce for autumn and winter work, yielding good tender heads of an attractive appearance.

The soil warming experiments with frames was continued, but owing to the excessively warm weather in March the relative effects of different soil temperatures were neutralised and no new knowledge was gained.

The mushroom experiments in the mushroom shed were concerned mainly with the question of casing soil. Once again a mixture of two thirds soil and one third peat proved superior to soil only.

Mushrooms were also grown in the temperature chambers of house 6, using two flat beds placed on the ground in each chamber, one bed being spawned with a white strain and one with brown. Two chambers were kept at an air temperature of 65°F., two at 60°F., and one at 55°F., while in the sixth chamber the heating pipes were shut off, but the beds were kept at 70°F. by means of electrically-heated wires placed beneath them. There was little difference in crop weight between the two highest temperatures, but at 55°F. air temperature the crop was appreciably lower, although the quality of the crop was the best in this chamber. Taking both quality and crop weight into consideration the best results were at an air temperature of 60°F.

Complete control of Rose Thrip (*T. fuscipennis* Hal.) upon a commercial nursery was effected by applications of Pyrethrum powder. For many years in succession this

pest had caused very severe losses of blooms in a large block of houses, but after applications of the powder at four-day intervals during March practically the whole of the first crop was marketed in April, and with further applications to each subsequent crop, no further injury was sustained.

Further observations upon the overwintering habits confirmed that the hibernating, fertile, female insects do not pass the winter in the ground, but do so in crevices in the glasshouse woodwork, amongst the shoots or the petals of any blooms in heated houses, and more rarely in the bark of dormant bushes. From November until January the insects, irrespective of temperature conditions, neither feed nor lay eggs.

Tomato Leaf-miner (*Phytomyza solani* Macq.) was received from the Channel Islands in May; the insect has on occasions caused some injury in British glasshouses. During the growing season it was bred through three complete generations, with a partial fourth in September when the larvæ entered the soil to hibernate as pupæ. Experimentally, complete protection from attack was obtained by fortnightly applications of nicotine sprays containing 1 part nicotine to 640 parts water (with a spreader such as saponin). In no case was injury of the plant observed, nor did any of the sprays kill larvæ within their mines. It is probable that the nicotine acts as a stomach poison to the adult flies when they feed upon the leaf surface prior to oviposition. Adult flies were killed when allowed access to foliage sprayed with 0.15% sodium fluosilicate and 2.5% sugar in combination: the latter caused no injury to the foliage of even very young plants, but scorching resulted if the sodium fluosilicate content was increased to 0.25%.

The removal from plants of leaves containing mines of the insect is not used as a control measure, as the larval period is extremely short (3—5 days) and the larvæ usually pupate in the ground. A very serious infestation of

Carnations at Basingstoke by caterpillars of the Yellow-Underwing Moth (*Triphaena pronuba* L.) was experienced in October. Injury to the foliage and flowers ceased after distribution of a poison-bait consisting of Paris green, bran and treacle solution. In the laboratory the caterpillars were attracted to and killed by this bait in a few hours, and they were also killed by an application of Derris dust to the foliage.

Caterpillars of the Angle-shades Moth (*Brotolomia meticulosa* L.) have been unusually abundant upon Chrysanthemums during the autumn. It is recommended that the plants be sprayed with lead arsenate as soon as they are housed, followed by a second application three weeks later. If this practice has not been resorted to, applications of powdered cryolite to the blooms appears to afford an efficient means of control.

An attack of Carnation Tortrix (*Tortrix pronubana* Hb.) upon cyclamen has been located in the Lea Valley: an account of this pest is given in the Carnation Year Book for the current year.

This pest has also caused serious injury to *Crassula coccinea* by eating out the growing points. It was controlled successfully by spraying with lead arsenate to which twice the usual amount of spreading agent, in this case saponin, was added. The advantage of the increased amount of saponin added is that the lead arsenate deposit is gradually removed by the normal watering operations.

Investigation into the possible use of jar-traps containing attractants for the control of Sciariid and Phorid flies in mushroom sheds is proceeding.

Investigations of the control of Capsid Bug on chrysanthemums have been conducted both at the Experimental Station and in commercial nurseries. Promising results have been obtained from the use of nicotine and derris dusts, and nicotine washes, and also by fumigation of the houses with calcium cyanide.

The investigation of cucumber root rot has been continued and a number of cultures of *Fusarium* spp. isolated previously have been tested for pathogenicity. None have proved active parasites, although several are capable of invading cucumber roots to a slight extent.

The injurious effect of excessive soil moisture on cucumber roots has again been demonstrated and last season's results confirmed.

A bacterial stem rot of the tomato has been observed several times during the present year. The identity of the organism concerned is being investigated.

Mycogone rosea has been isolated from diseased mushrooms submitted for examination and its pathogenicity established. While this parasite has been reported as infecting various other fungi it appears not to have been recorded on the mushroom previously.

The investigation of *Verticillium* wilt of the chrysanthemum has been continued and it has been established that infection may arise through contact with infected soil as well as through cuttings.

Preliminary investigations concerning chrysanthemum leaf blotch caused by *Septoria chrysanthemella* have been commenced.

Further experiments upon the control of *Verticillium* wilt of the carnation have been conducted. These indicate that the period during which cuttings from contaminated nurseries must be kept in pots before disease symptoms appear is appreciably shorter than had previously been accepted. Dip treatment of cuttings with a fungicide was unsuccessful owing to poor absorption of the fungicide, which incidentally proved more harmful to a batch of cuttings rooted in February than to those rooted in November.

The depth to which the roots of carnation plants normally penetrate has been carefully measured and, in the cases so far examined has not been found to exceed 2 feet, a depth that should permit of the destruction of contaminated debris by steaming after lifting of the old crop. Promising results are being obtained by nurserymen who have followed control recommendations.

The effect of various substances on the rooting of carnation cuttings in relation to infection by *Fusarium culmorum* has been investigated. The results suggest that infection was determined by the moisture relations rather than by any of the treatments.

Experiments on the mode of infection of the carnation by *Ustilago violacea*, the cause of Anther Smut, have resulted in infection through the cut surfaces left after cutting the flowers, but not through an unbroken surface or through the roots. The fungus has been virtually eliminated from a contaminated nursery solely by selection of stock without special treatment of the soil, which suggests that infection through the root does not take place.

Experiments on the control of the *Rhizoctonia* disease of lettuce in the seed tray by coating the seed and watering with fungicides do not warrant commercial recommendation.

A Phytophthora rot of fruits of early vegetable marrows in frames, not previously reported, has been recorded. The casual fungus probably a strain of *P. parasitica*, rapidly rots the fruits of other cucurbitaceous plants, such as cucumbers and melons, but does little damage to the tomato. It does not cause "damping off" in seedlings or any of these plants.

The study of lettuce mosaic has been completed. The virus was shewn to be transmitted through two- and three-year-old seed and the host range has been extended to various composite weeds also to garden pea and sweet pea; the last named plant shewing symptoms of a streak disease. A variety trial demonstrated large differences in the reactions of lettuce varieties to mosaic.

In order to elucidate the relationship of the lettuce mosaic virus to the already described viruses which attack leguminous plants, a survey of leguminous virus diseases has been started.

A preliminary study has been made of certain viruses of the *cucumber virus* 1 type found infecting lily, hyacinth, and tulip.

The effect of adding derris extracts to petroleum emulsions has been studied. The chief reason for this investigation was to discover a spray which would control both the tomato moth caterpillar and the red spider mite on tomatoes during the fruiting season. The possibility of reducing the oil concentration of petroleum emulsion sprays for red spider control arose from these investigations.

The control of red spider mite on carnations has also been investigated and in this connection a number of nurserymen have kindly consented to test two effective insecticides.

Serious loss of cucumber plants due to attack by the larvæ of sciarid flies has occurred during the year. Methods for the control of this pest which have proved fairly successful on other occasions were most unsatisfactory, and as a result many substances have been tested as insecticidal drenches for cucumber beds. None of these substances was effective and this problem must be regarded as one of major importance.

During the course of the year a number of dusts have been tried against heavy infestations of Thrips on roses growing in glasshouses, and a number of new substances tested for the control of tomato leaf mould, cucumber mildew and rose mildew. The results shew very clearly the advantage to be gained by incorporating petroleum oil emulsions with many fungicides.

The use of plant hormones in the propagation of the chrysanthemum and carnation is being investigated to determine their value for commercial work and also to ascertain if rooting is stimulated to such an extent that the

provision of special rooting media is unnecessary for cuttings treated with these hormones. A high percentage of decay at the base of cuttings rooted with the assistance of plant hormones has been observed on some nurseries, and this effect is being carefully sought for during the course of the investigations.

The chief physiological work during the past year has been the completion of a series of experiments on assimilation and translocation in the tomato seedling. These experiments represent the culmination of about five years' preliminary work and have involved a great deal of manipulation and calculation, over 26,000 separate measurements having been made. The calculation and statistical treatment of these results is in progress.

Work on vernalisation of tomato seeds has been carried out but the usual technique of cold treatment after germination appears to delay fruiting. There are indications, however, of an interesting line of attack which is now being pursued.

The past year's chemical work has confirmed the fact that ammonia is liberated at the surface of the soil in tomato houses. Several different methods have been employed in an attempt to measure the amount given off, but it has never been appreciable and corresponds to a very small fraction of the nitrate which is known to disappear when the soil is watered. It is considered, therefore, that the amount of nitrogen lost from the soil in this way is negligible.

Attempts have been made to discover a cheap and effective method for removing chlorates from contaminated pots. Washing with either cold or hot water is liable to be uncertain and of the numerous chemicals used a five per cent. solution of ordinary photographic hyposulphite is the best. Pots have been soaked in this

solution for two hours and then rinsed with cold water. After this treatment there has been no chlorate injury on plants planted in the pots concerned, neither does the solution have any effect on them.

The effect of manurial treatment of the soil on the composition of crops has been extended to crops other than the tomato. The results will be given when they are available.

Obituary.

It is with profound regret that we record the death of our friend, Mr. Joseph Harnett, at Easton Lodge, Enfield, on Monday, 30th May, 1938.

Mr. Harnett owned the Tunfield Nurseries, Hoddesdon, where for many years he was a successful cultivator of cucumbers, mushrooms, and tomatoes. He also made a speciality of pot azaleas, hydrangeas and polyantha roses, and more recently developed the well-known "J.H." brand of pure culture mushroom spawn.

It is true to say that he was a scientific horticulturist in the best sense of the word. One of the early members of the Committee of Management of the Research Station, he was one of its keenest supporters. He kept in constant touch with the work and did yeoman service by conducting extensive trials on his own nursery. He was a pioneer in steam sterilization of the soil, and with Mr. R. L. Glasspool was the first to heat the water in the nursery pipes by injecting steam.

He also raised two varieties of tomatoes, J.H. No. 1 and J.H. No. 2, the second of which in particular is being used extensively.

Mr. Harnett was keenly interested in the production of high-class fruit, flowers and vegetables. He served on the National Mark Fruit Trades Committee, and with Dr. W. F. Bewley he visited provincial markets for several seasons to report upon the condition of National Mark Produce.

He was a founder member of the Lea Valley Growers' Association, and served on the Committee of the now defunct British Glasshouse Produce Marketing Association.

Mr. Harnett's nursery was "open house" to all who were interested in the crops he grew. His advice and in many cases his material assistance was given freely to all who were in difficulty, and many who read these lines have reason to bless his name.

"J.H." as he was affectionately termed by his many friends, was a real English gentleman who spared not himself in the interest of his fellows. His like is not easily to be found, and he will be missed greatly by those who knew him. His memory will not perish, for his name has been written indelibly on the history of the glasshouse industry of this country.

DIRECTOR'S REPORT.

1. Experimental Results of 1938.

1. Tomatoes.

The practice of grading the tomato fruits from the experimental plots, adopted in 1921, was continued.

- A.—“Pinks” number 5 to 7, and “Pink and White” 8 to 10 to the lb. These are the best quality of fruit in size, shape, and colour; “Pinks” being slightly larger than “Pink and Whites.”
- B.—“Whites.” These fruits are of good colour but smaller than “Pink and White.”
- C.—“Blues.” This grade consists of fruits of good colour but larger and more irregular in shape than Grade A.
- D.—“Roughs.” Small mis-shapen fruits about the size of cherries.
- E.—Blotchy fruits which ripen irregularly.
- F.—Fruits shewing Blossom End Rot.
- G.—Fruits shewing the lesions of Stripe Disease.
- H.—Fruits shewing “Green Back.”

(a) Houses 2 and 3. Watering experiment.

In view of recent experiences at the Research Station in which a reduction in the amount of water applied has increased the yield and improved the quality of the fruit, it was decided to arrange a suitable experiment to test the effect of applying quantities of water below the normal rates of application.

Eight plots were provided in each of houses 2 and 3, and four treatments were arranged in blocks of four each.

The control treatment, which is the usual rate of watering at the Research Station, was one hour with an inch hose per house 100 feet long by 28 feet wide, neglecting the central path three feet wide. This equals 960 gallons per hour or 3.5 gallons per square yard.

Table 1.

Variety :—Ailsa Craig.

House	Plot	Treatment	Crop yield in lbs. per plant					Total tons per acre	Average tons per acre
			May	June	July	Aug.	Sept.	Total	
2	3	Usual amount of water. One hour per house (100 ft. $\times$ 28 ft.) with 1 inch hose ...	—	1.44	0.90	0.68	0.78	3.80	30.71
	8	" " " " " "	—	1.64	1.30	0.83	0.59	4.36	
	4	" " " " " "	—	1.36	1.05	0.85	0.55	3.81	
	7	" " " " " "	—	1.57	1.33	0.77	0.53	4.20	
2	5	Forty minutes with 1 inch hose per house ...	—	1.58	1.01	0.95	0.77	4.31	31.49
	7	" " " " " "	—	1.41	1.53	0.98	0.65	4.57	
	1	" " " " " "	0.01	1.71	1.42	0.66	0.69	4.49	
	3	" " " " " "	—	1.31	1.02	0.45	0.43	3.21	
2	2	Twenty minutes with 1 inch hose per house ...	0.01	1.48	1.66	0.87	0.59	4.61	32.18
	4	" " " " " "	—	1.47	0.87	0.78	0.94	4.06	
	2	" " " " " "	0.01	1.73	1.22	0.63	0.55	4.14	
	5	" " " " " "	—	1.04	1.07	1.20	0.82	4.13	
2	1	Very light watering frequently giving the minimum to prevent wilting ...	0.02	1.72	1.40	0.86	0.63	4.63	29.63
	6	" " " " " "	—	1.15	0.75	0.68	0.60	3.18	
	6	" " " " " "	—	1.04	1.02	0.88	0.55	3.49	
	8	" " " " " "	0.01	1.67	1.43	0.64	0.55	4.30	

Two other treatments were 40 minutes and 20 minutes per house with an inch hose or 2.3 gallons and 1.65 gallons of water per square yard respectively.

In the fourth treatment the plants received very light waterings, just sufficient to prevent wilting of the foliage.

Unfortunately these treatments could not be continued after the middle of June, because a heavy infestation of the roots by the eelworm *Heterodera marioni* caused wilting, and it was necessary to cover the soil with a layer of moist peat, one inch thick to save the crop. When this is done all water is applied as a light spray every two or three days to keep the peat moist. It is safe to say, however, that the lighter waterings between the beginning of March and the middle of June did not affect the crop, adversely. The type of growth varied in accordance with the amount of water applied, but not as much as might have been expected. Setting of the flowers proceeded normally. The crop results are detailed in Table 1.

b) Houses 4 and 5. Root restriction experiment.

The cultivation of tomatoes in pots, etc. for the purpose of root restriction during the early stages of the crop was continued in the south half of house 4 and in house 5. There were four treatments in each block of plots. In one the plants were planted in the ground in accordance with general practice, in another 10 in. clay pots standing on the top of the ground were used, and in two others the plants were planted in cardboard containers 8 in. $\times$ 8 in. $\times$ 8 in., and 6 in. $\times$ 6 in. $\times$ 6 in. respectively. These containers were provided with bottoms with a hole two inches square in the centre.

Boxes and pots were filled two thirds full with sterilized soil to which horse manure, base fertilisers and lime were added. They were top dressed later with peat to encourage surface rooting.

The results confirm those obtained previously in 1937 and 1936 respectively.

The earliest pickings occurred in the clay pots which averaged 1.69 lbs. per plant by the end of June. By the same time, the larger boxes has given 1.45 lbs. per plant and the smaller boxes 1.42 lbs. per plant, while the plants in the ground had yielded 1.28 lbs. per plant. As will be seen from Table 2, the final crop weights followed the same order. The quality of the fruit was poorest on the controls planted in the ground. There was little difference in quality from the plants in the different containers.

Variety:—Potentate × Kondine Red.

Table 2.

House	Plot	Treatment		Crop yield in lbs. per plant						Total tons per acre	Average tons per acre
				May	June	July	Aug.	Sept.	Total		
4 5	7	Planted in the ground	...	—	1.37	1.05	1.14	0.72	4.28	32.53	32.42
	1	"	"	—	1.35	1.15	1.03	0.96	4.49	34.12	
	6	"	"	—	1.11	1.35	1.15	0.52	4.03	30.61	
4 5	5	Planted in cardboard containers 6 in. × 6 in.	...	—	1.42	1.62	0.92	0.52	4.51	34.27	35.26
	3	"	"	—	1.42	1.75	1.11	0.47	4.75	36.09	
	8	"	"	0.01	1.40	1.70	1.10	0.45	4.66	35.41	
4 5	8	Planted in cardboard containers 8 in. × 8 in.	...	0.01	1.44	1.71	1.06	0.58	4.80	36.48	38.22
	5	"	"	—	1.46	2.10	1.37	0.52	5.45	41.42	
	7	"	"	—	1.43	1.84	1.07	0.50	4.84	36.78	
4 5	6	Planted in 9 inch clay pots	...	0.01	1.60	1.75	1.19	0.65	5.20	39.52	39.19
	2	"	"	—	1.78	1.55	1.00	0.52	4.85	36.86	
	4	"	"	0.02	1.66	1.80	1.25	0.69	5.42	41.19	

Table 3.

Variety:—E.S.1.

House	Plot	Treatment	Crop weight in lbs. per plant						Total tons per acre	Average tons per acre
			May	June	July	Aug.	Sept.	Total		
10	2	Control: planted in ground	—	1.49	1.83	1.53	0.92	5.77	43.86	42.75
	1	"	0.06	1.36	1.70	1.25	1.11	5.48	41.64	
	7	Planted in size 32 pots with large hole in bottom stood on the ground	0.03	1.40	2.11	1.88	1.07	6.49	49.34	
	8	Planted in cardboard boxes 6 in. × 6 in. × 6 in.	0.07	1.58	2.68	1.89	1.17	7.39	56.16	

Table 4.

Variety :—E.S.1.

House	Plot	Treatment	Crop weight in lbs. per plant					Total tons per acre	Average tons per acre
			June	July	Aug.	Sept.	Oct.		
11	1	Planted in the Ground	0.79	1.92	1.85	1.27	0.40	47.35	46.17
	2	"	1.23	1.70	1.51	1.19	0.35	45.45	
	7	"	1.06	1.94	1.66	1.22	0.31	47.04	
	8	"	0.88	2.27	1.74	0.65	0.36	44.84	
3	Planted in Cardboard Containers 8 in. × 8 in.		1.16	1.84	1.97	1.19	0.28	48.94	50.52
	4	"	1.03	2.03	2.14	1.35	0.30	52.10	
5	Planted in cardboard containers 6 in. × 6 in.		0.89	1.90	1.74	1.45	0.24	47.27	45.56
	6	"	1.15	1.66	1.61	1.12	0.23	43.85	

In house 10, two plots were planted in the usual manner. In a third plot cardboard containers (6 in. $\times$ 6 in. $\times$ 6 in.) were used and in a fourth plot the plants were potted into size 32 pots which were then stood on the surface of the soil. In the last case, although a large hole had been made in the bottom of each pot, rooting through into the soil below was irregular and slow in some cases, and some plants became very hard before the roots penetrated into the ground. The results, see table 3, are interesting. The plants in the ground gave 5.62 lbs. per plant, those in the size 32 pots 6.49 lbs., and those in the 6 in. $\times$ 6 in. $\times$ 6 in. cardboard containers 7.39 lbs. per plant respectively. In house 11, half the plants were planted in the ground, a quarter in 8 in. $\times$ 8 in. $\times$ 8 in. cardboard boxes and an equal number in 6 in. $\times$ 6 in. $\times$ 6 in. containers. The first yielded 6.07 lbs., the second 6.64 lbs. and the third 6.0 lbs. per plant, Table 4.

All these results indicate that earlier and heavier yields of good quality fruit can be obtained by planting in containers and growers would be well advised to test them in their nurseries.

(c) Houses 7—9. Soil sterilization.

By the end of the 1937 season the soil in houses 7—9 was highly infested with the tomato root eelworm *Heterodera marioni*, and it was decided to test the effect of treating it with formaldehyde, cresylic acid, and a proprietary sterilizer, the last being used at two different strengths. Particulars of the treatments and crop results are given in table 5.

The proprietary sterilizer had proved particularly effective against eelworms during the previous two years, when applied six weeks before planting tomatoes. For the 1938 experiments all the sterilizers were applied at the beginning of November before the winter lettuce crop of Cheshunt Early Giant.

None of the treatments was successful in destroying the eelworms in the soil. By the end of June plants in every plot irrespective of the sterilizer used shewed typical signs of severe root injury associated with eelworm attack. There was a paling and yellowing of the foliage and weakening of the top growth. Examination of the roots shewed severe infestation. On the other hand the general appearance of the plants were uniformly different on plots treated with the different sterilizers. The best plants were from the plots treated with formaldehyde and the second best from the plots treated with cresylic acid. The relative effects of these two sterilizers were quite typical and conformed to past experience.

Table 5.

Variety:—E.S.1.

House	Plot	Treatment	Crop weight in lbs. per plant						Total tons per acre	Average tons per acre
			May	June	July	Aug.	Sept.	Total		
7	4	Formaldehyde, 1 gallon to 49 gallons water over 7 square yards ...	0.26	2.36	2.98	2.18	0.88	8.66	65.83	51.95
	8	" " " " " " " " " " " " " " " "	0.12	1.92	2.03	1.74	0.83	6.64	50.46	
8	2	" " " " " " " " " " " " " " " "	0.28	1.79	1.73	1.63	0.73	6.16	46.81	
	4	" " " " " " " " " " " " " " " "	0.12	2.04	2.17	1.74	1.02	7.09	53.88	
9	6	" " " " " " " " " " " " " " " "	—	1.44	2.09	1.89	0.79	6.21	47.19	51.52
	7	" " " " " " " " " " " " " " " "	0.02	1.55	2.16	1.65	0.87	6.25	47.50	
7	1	Cresylic acid, 1 gallon to 39 gallons water over 7 square yards ...	0.21	2.17	2.65	1.74	0.61	7.38	56.09	
	6	" " " " " " " " " " " " " " " "	0.26	2.12	2.14	1.95	0.82	7.29	55.41	
8	5	" " " " " " " " " " " " " " " "	0.05	1.82	2.20	1.69	0.85	6.61	50.23	46.25
	8	" " " " " " " " " " " " " " " "	0.20	1.97	2.03	1.49	0.79	6.48	49.26	
9	1	" " " " " " " " " " " " " " " "	0.11	1.53	2.06	1.51	0.92	6.13	46.60	
7	5	A proprietary Sterilizer, 1 gallon to 99 gallons water over 7 square yards ...	0.15	2.20	2.08	1.79	0.83	7.05	53.58	
	7	" " " " " " " " " " " " " " " "	0.28	1.88	1.83	1.70	0.60	6.29	47.81	46.66
8	1	" " " " " " " " " " " " " " " "	0.23	1.61	1.61	1.46	0.74	5.65	42.94	
	3	" " " " " " " " " " " " " " " "	0.19	1.64	1.53	1.59	0.88	5.83	44.31	
9	5	" " " " " " " " " " " " " " " "	—	1.33	2.18	1.69	1.00	6.20	47.13	
	8	" " " " " " " " " " " " " " " "	0.07	1.55	1.75	1.30	0.82	5.49	41.72	46.66
7	2	As above, 1 gallon to 99 gallons water over 14 square yards ...	0.31	2.12	2.54	1.95	0.72	7.64	58.07	
	3	" " " " " " " " " " " " " " " "	0.27	2.20	2.69	2.13	0.79	8.08	61.42	
8	6	" " " " " " " " " " " " " " " "	0.10	1.53	1.49	1.47	0.79	5.38	40.90	
	7	" " " " " " " " " " " " " " " "	0.16	1.44	1.36	1.36	0.73	5.05	38.38	46.66
9	2	" " " " " " " " " " " " " " " "	0.10	1.51	1.72	1.27	0.87	5.47	41.57	
	3	" " " " " " " " " " " " " " " "	0.03	1.45	1.71	1.24	0.78	5.21	39.61	

Wilting became so severe that the soil of every plot was covered with a layer of moist peat, 1 inch thick, at the beginning of July. New roots grew out quickly into the peat and as these do not become so severely attacked by eelworms as the roots in the soil beneath, the plants recovered their turgor in about ten days and continued to bear fruit until the end of September.

The total weights of between 46 and 52 tons per acre pay tribute to the effectiveness of the peat treatment, which incidentally is being used widely in various parts of the country.

As will be seen from Table 5 there was little difference in crop from plants in soil treated with formaldehyde and cresylic acid. Both gave slightly better results than the proprietary sterilizer.

The ineffectiveness of the cresylic acid and the proprietary compounds is unusually disappointing and may be due partly to the time of application. The root knots had little time to decay before the sterilizers were applied and many eelworms would be protected by the plant tissue which surrounded them. It may be best to delay treatments of this kind until the old root tissue has decayed and the eelworms have passed out into the soil.

The houses will be steamed by the Hoddesdon pipe system before planting the tomato crop in 1939.

(d) Variety trials.

The variety trials previously conducted in house 5 were transferred to house 1. The results are given in Table 6.

Crop yields were low owing to root damage by *Heterodera marioni*. The varieties tested were chiefly new crosses made during 1937. Helvetia × E.S.1, E.S.1 × Potentate × Kondine, and Bides Recruit × Potentate × Ideal proved the best.

The leaf mould resisting varieties are improving each year. They have been tested in small quantities on many nurseries in different parts of the country and many excellent reports have been received. The best of them appears to be Stirling Castle × E.S.1 × Radio, identified as Leaf Mould Resister 1. Small quantities of seeds are available for distribution.

Table 6.

Variety	Crop yield in lbs. per plant					Total tons per acre	Quality of fruit: Percentage in Grade				
	May	June	July	Aug.	Sept.		A	B	C	D	E
Bides Recruit × Potentate × Ideal F.1	—	1.72	1.49	1.10	0.65	4.96	53	4	34	2	7
Helvetia × E.S.1 F.1 ...	—	1.14	1.38	1.06	1.32	4.90	86	8	3	1	2
E.S.1 × Potentate × Kondine F.1...	0.03	1.79	1.44	0.74	0.79	4.79	75	7	7	2	8
E.S.1 × Master Marglobe ...	—	1.65	1.34	0.85	0.69	4.53	82	8	2	1	7
E.S.1 × Potentate ...	—	1.50	1.41	0.85	0.73	4.49	66	9	8	2	13
Potentate × Kondine × E.S.1 F.1...	—	1.55	1.56	0.76	0.58	4.45	74	9	6	4	7
Jubilee × Ideal F.1 ...	—	1.79	1.43	0.80	0.43	4.45	73	5	11	1	7
Lucifer × Best of All ...	—	1.16	1.63	1.04	0.55	4.38	80	10	2	3	5
Tuckerswood × Radio ...	—	1.61	1.46	0.75	0.54	4.36	77	11	6	2	4
Ideal × E.S.1 × Up to Date × Potentate F.1 ...	—	1.22	1.79	0.73	0.60	4.34	69	5	13	2	8
E.S.1 × Ideal F.1 ...	—	1.37	1.23	1.06	0.62	4.28	78	9	4	2	7
Radio ...	—	1.28	1.36	0.93	0.70	4.27	77	13	2	4	3
Blaby × Potentate ...	—	1.31	1.44	0.82	0.69	4.26	54	4	29	3	8
Ideal ...	—	1.36	1.63	0.79	0.32	4.10	73	10	2	2	9
Solidarity ...	—	1.37	1.54	0.66	0.48	4.05	64	7	14	3	10

2. Cucumbers.

The cucumber experiments this year were concerned with the composition of the beds, the plots being randomised in each house to permit of statistical examination.

Three mixtures were used as follows :—

- (a) Two parts by volume of turfy virgin soil, and one part long horse manure.
- (b) Two parts soil and one part clean wheat straw, adding sufficient dried blood to compensate for the lower nitrogen content.
- (c) Two parts soil, one part straw, and one part horse manure.
- (d) Two parts soil, one part horse manure, one part sphagnum peat.

The ground on which the beds were placed (namely “the base”) was not sterilized by steam as in previous years but was treated with chemical sterilizers as follows :—

House C.—Proprietary sterilizer A, manufacturer's recommended strength.

Houses D, F, and G.—Proprietary sterilizer B, manufacturer's recommended strength.

House E.—Formaldehyde, 1 gallon 40% in 49 gallons of water to 7 square yards.

The beds were prepared by moulding them between boards, placed at the back and front, lengths of 10 feet being prepared at a time and the mixture was compressed before moving the boards. Considerable difficulty was experienced in mixing the materials together so the work was done by placing walls of soil, manure, etc., in a semi-vertical position. When finished, the beds were 18 inches wide at the base and slightly narrower at the top. The height was 12 inches.

The beds were thoroughly wetted and then allowed to dry and warm up to a temperature of 65° to 70°F. before planting. During the season, the beds were kept as upright as possible by adding compost in small quantities to the top only of the bed.

The results given in Table 7 indicate that the mixture of two parts soil and one part straw to which dried blood was added is inferior to soil and horse manure.

The addition of one part of straw to the standard mixture of two parts soil and one part horse manure did not affect the crop yield. This is surprising because on many commercial

Table 7.

House	Plot	Composition of beds	Crop yield in lbs. per plant							Total tons per acre	Total tons per acre	
			Mar.	April	May	June	July	Aug.	Sept.			Total
C	1	2 parts soil: 1 part horse manure	2.80	11.43	7.52	7.48	8.72	5.61	1.10	45.16	67.74	1.37
	4	" " " " " "	1.72	10.93	7.75	6.56	8.27	5.91	0.82	41.96	62.94	1.27
	4	" " " " " "	2.58	11.37	8.88	10.06	8.84	6.29	0.38	51.40	77.10	1.56
	7	" " " " " "	3.45	10.30	7.86	8.09	7.32	5.61	0.94	43.57	65.36	1.32
	2	" " " " " "	3.66	11.86	8.26	9.98	5.90	6.29	0.65	46.60	69.90	1.41
F	6	" " " " " "	3.19	11.92	8.42	8.93	8.39	5.40	0.41	46.66	69.99	1.41
	4	" " " " " "	2.48	10.00	6.88	9.38	8.50	5.12	0.37	42.73	64.10	1.29
	5	" " " " " "	3.14	10.62	8.62	9.87	9.37	5.74	0.43	47.79	71.60	1.48
G	3	" " " " " "	4.54	12.48	7.71	9.10	9.65	10.47	0.56	54.51	81.77	1.65
	5	" " " " " "	4.41	14.41	8.10	7.77	10.07	9.01	0.42	54.19	81.29	1.64
C D E F G	3	2 parts soil: 1 part wheat straw (dried blood added)	1.35	11.14	7.77	9.39	8.82	7.37	0.62	45.46	68.19	1.37
	5	" " " " " "	1.59	9.87	6.35	5.52	7.94	5.44	—	36.71	55.07	1.11
	2	" " " " " "	3.28	11.87	7.16	7.21	6.32	4.47	0.35	40.66	60.99	1.23
	5	" " " " " "	3.60	10.88	7.04	6.88	7.40	5.19	0.22	41.21	61.82	1.25
	3	" " " " " "	3.18	12.66	8.88	12.26	8.10	4.48	0.55	50.11	75.17	1.52
	5	" " " " " "	2.89	8.41	5.77	9.46	8.62	4.71	0.12	39.98	59.97	1.21
	3	" " " " " "	3.11	9.67	7.68	8.00	6.62	3.80	0.27	39.15	58.73	1.18
	7	" " " " " "	3.11	9.89	7.09	6.66	5.41	3.93	0.16	36.25	54.38	1.10
	2	" " " " " "	4.47	10.86	5.02	6.08	4.23	5.04	0.31	36.01	54.02	1.09
	2	" " " " " "	4.43	10.36	4.80	4.80	5.44	5.78	0.38	35.99	53.99	1.09
	6	" " " " " "										

Table 7 (continued).

House	Plot	Composition of beds	Crop yield in lbs. per plant								Total tons per acre	
			Mar.	April	May	June	July	Aug.	Sept.	Total		
C	2	2 parts soil: 1 part straw; 1 part horse manure ...	2.47	11.56	9.30	9.23	8.89	5.61	1.10	48.16	72.24	1.46
	6	" "	2.40	10.06	7.25	7.81	7.86	5.29	0.52	41.19	61.79	1.25
D	3	" "	3.43	13.16	8.31	7.82	8.29	5.80	0.60	47.41	71.12	1.46
	6	" "	3.23	9.78	8.08	7.60	7.76	5.15	0.46	42.06	62.09	1.27
E	4	" "	3.41	10.78	8.41	12.09	8.16	5.93	0.74	49.52	74.28	1.50
	7	" "	2.99	11.47	8.69	11.15	7.60	5.06	0.73	47.69	71.04	1.45
F	2	" "	2.75	11.99	9.48	9.49	8.78	5.28	0.78	48.55	72.83	1.47
	6	" "	3.14	10.57	8.45	6.59	6.93	3.32	0.14	39.14	58.71	1.19
G	4	" "	3.74	11.69	8.21	11.10	9.68	9.66	0.77	54.85	82.26	1.66
	7	" "	2.68	11.07	8.59	8.03	7.64	11.00	1.29	50.30	75.45	1.52
D	8	2 parts soil: 1 part horse manure: 1 part peat ...	2.98	10.83	5.86	6.36	5.15	4.89	0.39	36.46	54.69	1.10
G	8	" "	5.59	12.87	7.50	8.39	7.63	8.33	0.69	51.00	76.50	1.55

nurseries it has been most effective and has become routine practice. It may be due to the good physical state of the standard mixture which was carefully prepared from good turfy soil and kept in neat condition with upright sides.

On heavier, closer and wetter soils the addition of straw leads to a more open condition of the beds resulting in cleaner root action and increased crops.

The addition of peat also had little effect.

The effect of the different chemical sterilizers on the floor of the house is seen in the following Table:—

House		Treatment		Average crop yield in tons per acre	
C	...	Proprietary steriliser	A	...	61.16
D	...	"	"	B	64.88
F	...	"	"	B	63.40
E	...	Formaldehyde	...	...	70.06

} 64.14

It is interesting to note that formaldehyde gave the best result of all the compounds tested.

3. Lettuce.

The crops of Cheshunt Early Giant lettuce in the tomato houses during the winter were again successful. This variety is becoming well established as an autumn and winter crop and in the hands of experienced growers the results are satisfactory especially in districts that are favoured with good light. There is an increasing demand on the part of the public for fresh salads, and with a little effort home grown lettuce could be made a popular article of food.

Cheshunt Early Ball lettuce, which is especially suitable for cold frames, is not grown as extensively as it should. It hearts freely and is an attractive tender lettuce. It gained the first prize in the cold frame section at the Early Market Produce Show, Vincent Square, London, two years in succession. Those who specialise in cold frame work would be well advised to test it. Seed can be obtained from the Experimental Station by those who require it.

4. Soil Warming under Frames.

These experiments were conducted with lettuce, carrots, cauliflowers, tulips and narcissi. The effect of the soil warming was completely neutralised by the unusually warm weather of last March. Soil temperatures were uniform at approximately 65°F. and in consequence the crops in the various sections matured at the same time.

5. Mushrooms.

The mushroom experiments were concerned mainly with the question of casing soil, of which there were four variations, namely, sterilized soil only; two parts soil with one part peat; two parts soil with one part small stones; and two parts soil with one part peat and one part small stones. Four shelves were devoted to this experiment, the four treatments being randomised on each shelf. The experiments were not very satisfactory because secondary fermentation commenced some five weeks after spawning, and although it was not accompanied by any appreciable increase in bed temperature a sweet smell reminiscent of molasses could be detected on opening up the bed, and the total crop was not satisfactory. The highest yields, however, occurred where the casing soil contained one third peat.

On the fifth shelf the effect of mixing with the manure cotton seed meal either alone or with gypsum, during the process of fermentation, was tested.

The secondary fermentation to which reference is made above had been observed in previous crops on several commercial nurseries, and the object of incorporating cotton seed meal at the first turning was to accelerate fermentation in the hope that materials which sometimes undergo fermentation after the beds have been made would be broken down during the period of preparation. The results were promising, for the crop was increased by the addition of the meal, especially when gypsum was also added.

On the last shelf, manure 4 inches deep was used instead of the usual depth of 8 inches. In one half of the shelf it was placed over 4 inches of good loam, while under the other half were laid a number of water troughs and electric heating cables, which were used for maintaining a bed temperature of 70°F. and ensuring that the manure was kept moist by generating water vapour from the troughs when necessary.

The results were not conclusive and the experiment will be repeated.

The results of the above experiments are detailed in Table 8.

Another crop of mushrooms was grown in house 6, where they were submitted to different air temperatures. Each chamber contained two 8 inch flat beds placed directly on the ground, but separated by a path 2 feet wide. One bed was spawned with a brown strain and one with a white strain.

Table 8.

Plot	Colour of Straw	Casing soil mixture	Compost	Weight in lbs. per square foot				Total number per sq. foot	Average weight of Mushroom in ounces
				April	May	June	July	Total	Average total
A1	White	Station soil only	Gypsum added	0.94	0.74	0.10	—	1.78	32.05
B4	"	"	"	0.74	0.37	0.05	0.05	1.21	20.21
D4	"	"	"	0.11	0.74	0.05	0.05	0.95	14.63
E4	Brown	"	omitted	1.08	0.76	0.20	0.20	2.24	32.84
A4	White	Soil 66%, peat 33%	added	0.84	0.40	0.07	—	1.31	21.95
B1	"	"	"	1.11	0.63	0.05	0.05	1.84	38.89
D2	"	"	"	0.57	0.68	0.05	—	1.30	20.58
E1	Brown	"	omitted	1.48	0.88	0.16	0.24	2.76	43.48
A2	White	Soil 66%, stones 33%	added	0.74	0.63	0.11	—	1.48	23.42
B3	"	"	"	0.68	0.79	0.11	0.10	1.68	30.11
D1	"	"	"	0.48	0.37	—	—	0.85	18.84
E3	Brown	"	omitted	1.24	0.88	0.28	0.20	2.60	35.81
A3	White	Soil 50%, peat 25%, stones 25%	added	0.84	0.43	0.05	—	1.32	26.00
B2	"	"	"	0.89	0.63	0.11	0.05	1.68	31.11
D3	"	"	"	0.42	0.53	0.01	—	0.96	24.21
E2	Brown	"	omitted	1.44	0.64	0.16	0.16	2.40	30.80
F1	Brown	Soil only	Cotton seed meal added	0.88	1.08	0.16	0.12	2.24	28.64
F2	White	"	"	0.74	1.05	0.26	—	2.05	35.21
F3	"	"	"	1.05	0.90	0.30	0.05	2.30	44.26
F4	Brown	"	Cotton seed meal and gypsum added	1.48	0.96	0.32	0.11	2.87	32.60
C1	"	"	4 in. bed over 4 in. soil kept at 75°F. electrically	1.52	0.56	0.04	—	2.12	24.64
C2	"	"	"	1.52	0.68	0.08	—	2.28	32.80
C3	"	"	4 in. bed unwarmed	1.20	0.80	0.24	0.10	2.34	27.04
C4	"	"	"	0.40	0.36	0.08	0.04	0.88	9.60
			"						1.47

Table 9.

Plot	Temperature of air	Colour of strain	Weight in lbs. per square foot					Total numbers per sq. foot	Average weight of mushroom in ozs.
			Jan.	Feb.	March	April	Total		
1a	65°F.	...	0.26	1.12	0.37	—	1.75	22.81	1.23
1b	"	...	0.03	0.96	0.22	0.01	1.31	19.56	1.11
2a	"	...	0.32	1.19	0.37	0.10	1.98	28.00	1.13
2b	"	...	0.17	0.93	0.33	0.03	1.46	20.05	1.16
3a	60°F.	...	0.26	0.90	0.25	0.01	1.52	19.12	1.21
3b	"	...	0.23	0.70	0.23	0.02	1.18	19.92	0.95
4a	"	...	0.35	1.23	0.43	0.09	2.10	30.52	1.10
4b	"	...	0.13	1.13	0.42	0.03	1.71	34.68	0.79
5a	55°F.	...	—	0.58	0.47	0.35	1.40	15.86	1.41
5b	"	...	—	0.23	0.23	0.33	0.79	11.64	1.08
6a	Unheated bed kept at 70°F. electrically	...	0.16	0.82	0.37	0.09	1.44	18.60	1.24
6b	" " "	...	0.22	0.38	0.12	0.01	0.73	28.20	0.41

Two chambers were maintained at an air temperature of 65°F., two at 60°F. and one at 50°F., while the last was unheated. The beds in the last chamber were maintained at a steady temperature of 70°F. by means of electrically heated cables placed beneath them.

The effect of the air temperature on mushrooms is interesting (Table 9). The two brown plots averaged 1.87 lbs. per square foot at 65°F. and 1.81 lbs. per square foot at 60°F., while at 55°F. the weight was 1.40 lbs. per square foot in twelve weeks.

The two white plots averaged 1.39 lbs. per square foot at 65°F., 1.50 lbs. per square foot at 60°F. and 0.79 lbs. per square foot at 55°F. Thus while the brown strain works equally well at 65°F. and 60°F., the white strain requires 60°F. This is just another proof that the white strains of mushrooms are more exacting in their requirements than the brown strains.

The unheated chamber provided an interesting experiment. When the mushrooms appeared they developed differently from those in all other chambers. They pushed up large "mole hills" of casing soil which broke and revealed large clumps of big mushrooms, whereas in the other chambers the mushrooms appeared much nearer the surface. In the first instance the white strains were badly stained by the damp casing soil.

When the first flush had been picked the pipes were turned on and the air maintained at a temperature of 55°F. Under these conditions the mushrooms developed at the surface of the beds as in the other chambers. Three weeks later the pipes were turned off and the air allowed to cool, with the result that the mushrooms developed as in the first flush, pushing up large mounds of soil, which broke up to reveal mushrooms beneath. Ultimately it was found that the habit could be altered at will by adjusting the air temperature in relation to that of the beds.

With a bed temperature of 70°F. and air temperatures below 50°F. the mushrooms develop deeply in the beds and push up the casing soil in mounds before coming to the surface, but at temperatures of 55°F. and above they develop in the normal manner.

The other point which emerges is that 60°F. is probably the best temperature for the mushroom crop, taking into consideration crop weight and quality of the produce. It must be borne in mind, however, that the mushrooms at 55°F. were slightly heavier and firmer than those at 60°F.

2. Plant Diseases.

In 1938, 512 specimens were received and reported upon. They may be roughly classified as follows:—

General Mycology (Tomatoes, etc.)	...	250
Virus Diseases		133
Flower Diseases		109
Vegetable Diseases		20

Previously it has been the custom to print a list of all new plant diseases which have been reported each year, and this list has now grown to about 50 items per year. Of the diseases listed, only a few are new to science or of importance to growers. It has been decided, therefore, to omit the list and to replace it by short notes on the more important diseases submitted for examination during the year.

1. New and Important Diseases.

P. H. WILLIAMS.

During the past season many samples of tomato fruit which have been received shewed bronzing of the skin. When cut open the vascular bundles and the flesh were usually light brown in colour. This occurs where the subsoil has become dry so that the plant is unable to obtain sufficient water for its needs. The remedy is to keep the soil sufficiently moist throughout the season.

Two cases have occurred of foot rot of the cucumber caused by *Rhizoctonia solani*. This fungus has not previously been reported on this host. The tissues were decayed except for the vascular bundles. The source of infection was probably the soil, although possibly potatoes attacked by the fungus were present in the manure. Manure infected in this manner has led on several occasions during recent years to attacks of *Rhizoctonia* foot rot of the tomato. As with the tomato, diseased cucumber plants should be removed and the hole treated with 0·25% solution of uspulium before replanting.

Melon plants from Hampshire were found to be suffering from a soft rot caused by *Bacterium carotovorum* (*Bacillus carotovorus*). The stems were almost completely decayed. In such cases thorough disinfection of the soil with formaldehyde or steam should prevent a recurrence of the disease in the crop following.

Clitocybe dealbata has been found growing as a "weed" in mushroom beds. In the particular case examined no damage was done as it was confined to the edges of flat beds on the ground. It may, however, be a serious trouble when growing over the surface of the beds and successfully competing with the mushroom. It is of interest to note that many of the *Clitocybe* fruit bodies were deformed, shewing supplementary gills on the upper surface of the cap. This condition is somewhat similar to the Rose Comb Disease of the mushroom.

Since the Truffle fungus, *Pseudobalsamia mucrospora*, was first reported in this country (22nd Ann. Rep.) no further specimens have been received at this Station. During the last five months of 1938 it was, however, reported by other workers in four localities, each in a different county, namely, Kent, Surrey, Middlesex and Berkshire. It appears likely that further outbreaks of this fungus will occur in the future and that it may become more common. Growers are advised to send in any suspicious growths they may find in their beds for identification as it is essential to treat this disease in its early stages if it is to be controlled.

2. Cucumber Root Rot.

P. H. WILLIAMS.

Continuing the experiments on cucumber root rot, forty-three cultures of *Fusarium* spp. have been tested for pathogenicity to the cucumber. These cultures fall into three groups, characterised as follows:—

- A. White mycelium with spores produced in slimy cream to green masses. The spores are mostly 3-septate, but non-septate and 1-septate spores also occur both in the spore masses and scattered in the mycelium. The 3-septate spores measure $34 \times 5.1\mu$, the non-septate $12.7 \times 4.3\mu$ and the one-septate $17.5 \times 4.6\mu$. These characters seem to agree closely with the descriptions of *Fusarium solani*.
- B. Mycelium white with blue or purple colour in the medium which may also spread into the mycelium. Terminal intercalary chlamydospores are present. The spores are 0—4-septate, scattered in the mycelium. The 3-septate spores measure $33 \times 3.7\mu$, 1-septate $15 \times 3.3\mu$ and non-septate $10 \times 2.6\mu$.
- C. Mycelium red to brown, white at top of tube with a red stroma and red colour in medium. The spores are borne scattered in the mycelium or in dark brown masses. The 4-septate spores measure $32 \times 5.6\mu$, 3-septate $28 \times 5.5\mu$, 2-septate $22 \times 5.4\mu$, and 1-septate $16 \times 4.2\mu$.

The exact species represented in the last two groups have not yet been determined.

The method employed was described in the 23rd Annual Report. It was found that in many cases a small percentage of the roots of plants grown in inoculated soil shewed slight browning, and from them it was possible to reisolate the fungus. Thus ten strains of *Fusarium* A. were reisolated out of seventeen tested, seven of *Fusarium* B. out of twenty-two, and none of *Fusarium* C. out of four tested.

Even in plants from which *Fusarium* was reisolated other organisms such as *Mucor*, *Trichoderma* and various bacteria were isolated from precisely similar roots. These organisms are not generally considered as parasites and it may be suggested that the primary cause of the superficial browning of the roots must be looked for elsewhere than in fungal attack. It has been noted frequently that a varying number of root tips become dark brown. In some cases the root then ceases to grow although new and clean lateral roots have grown out from the brown portion. In other cases the root has obviously grown beyond the brown portion leaving a zone of dark brown tissue further back. In plants grown in pots standing in pans of water most of the root tips turn brown in a similar way when they penetrate the wet soil. In the case of the plants grown in bottles it may well be that the distribution of moisture in the soil remains uneven and that certain parts of the soil are wetter than others. The browning of some roots may be due to their passing through such areas of wet soil. In any case the pathogenicity of these *Fusaria* would appear to be very slight.

It has been previously reported that when cucumbers are grown in pots standing in pans of water, the roots die when they penetrate the water-logged soil at the bottom of the pot. This observation has been confirmed in the present season.

In one experiment soil was inoculated with cultures of the three types of *Fusarium* growing on sand and oatmeal. This soil was used to fill size sixty pots in which cucumbers were sown. A fourth series of pots was prepared in which sterile sand and oatmeal was added to the soil. After germination, each series was divided as before into three lots, one subjected to normal treatment, one kept dry and the third stood in pans of water. As in previous experiments in all plants which were kept wet, a large proportion of the roots shewed black tips and became brown when they penetrated the wet soil. A *Fusarium* of B. type was isolated from certain

of these roots in all series including the control. *Fusarium A.* also appeared in one isolation from a plant growing in soil inoculated with that fungus. It did not appear that the presence of any of these *Fusaria* increased the amount of disease present.

Most of the plants which were kept dry remained healthy although a few roots shewed browning. *Fusaria* were not isolated from them except in the case of the soil inoculated with *Fusarium B.*

In the plants receiving normal treatment the controls remained healthy as did those in soil inoculated with *Fusarium C.* In the other cases there was slight yellowing of some roots and *Fusarium B.* was again isolated.

In another experiment the effect on the amount of root rot of adding stable manure to the soil was tested. Four lots of soil were prepared, one of which contained no manure, the second 1 part of manure to 3 parts soil, the third 1 part of manure to 1 of soil and the fourth 3 parts manure to 1 of soil. Each lot was divided into two and one part sterilized in the autoclave. The soil was then used to fill size sixty pots and cucumbers were sown. After germination each soil series was divided into three lots of five plants each and subjected to the same moisture conditions as before.

Table 1 shews the wet weight of plants washed free from soil fourteen days after germination and Table 2 the number of plants which shewed some browning of the roots.

Table 1.

Wet weight of plants in grammes after 14 days growth.

Sterilized						Dry	Normal	Wet
Soil only ...	...	...	...	...	...	1.02	2.11	0.77
3 soil, 1 manure	...	...	...	...	...	3.31	3.42	2.91
1 soil, 1 manure	...	...	...	...	...	4.35	3.63	3.43
1 soil, 3 manure	...	...	...	...	...	1.95	2.56	2.12
Unsterilized								
Soil only ...	...	...	...	...	...	2.97	3.17	3.14
3 soil, 1 manure	...	...	...	...	...	6.62	5.86	5.17
1 soil, 1 manure	...	...	...	...	...	5.05	5.07	4.67
1 soil, 3 manure	...	...	...	...	...	5.44	6.10	4.94

Table 2.

Number of plants shewing injury to roots.

						Dry	Normal	Wet
Sterilized								
Soil only ...	...	...	...	...	...	4	3	4
3 soil, 1 manure	...	...	...	...	...	0	0	5
1 soil, 1 manure	...	...	...	...	...	0	1	3
1 soil, 3 manure	...	...	...	...	...	0	0	5
Unsterilized								
Soil only ...	...	...	...	...	...	1	1	1
3 soil, 1 manure	...	...	...	...	...	0	1	3
1 soil, 1 manure	...	...	...	...	...	0	0	2
1 soil, 3 manure	...	...	...	...	...	0	1	4

It is interesting to note that growth was more active in the unsterilized soil and mixtures, and that the addition of stable manure led to increased growth in both series. The amount of root damage was also reduced where stable manure was added. This is no doubt due in part at least to the opening up of the soil by the manure. The fact that almost all the plants grown in sterilized soil alone shewed some browning of the roots tends to confirm the suggestion that the trouble is primarily due to unfavourable soil conditions. The effect of water-logging of the soil was again well marked.

3. A Rare Mushroom Disease.

P. H. WILLIAMS.

In November, 1938, diseased mushrooms were received from a nursery in Berkshire which proved to have been attacked by *Mycogone rosea*. This fungus appears not to have been recorded on the mushroom previously. It has, however, been reported as attacking other fleshy fungi.

The surface of the caps of the diseased mushrooms was dark brown and the tissue underneath was stained bright yellow. In some cases parts of the tissue was also dark brown and in two instances this brown tissue shewed alternate zones of brown and white. Above the brown areas the surface was often slightly sunken.

Mycogone rosea was isolated from the brown tissue in the cap. It differs from *M. perniciosus*, the cause of White Mould or "Bubbles" disease of mushrooms, in the size and colour of the spores. The upper cell of the spores

averaged 35.5μ in diameter and the lower 20.8μ compared with 22.4μ and 15.5μ respectively in a culture of *M. perniciosa*. Both fungi produce the same type of growth on culture media but *M. rosea* has always a distinctly pink-brown colour in contrast with the dark brown of *M. perniciosa*.

The pathogenicity of the fungus was proved by inoculation experiments. In the first experiment, spores and mycelium were placed on the surface of the cap. After five days the fungus had penetrated about $\frac{1}{4}$ inch into the cap, the tissues of which were turned brown. In one case, a yellow colour was produced similar to that in the original specimens. The fungus was reisolated without difficulty.

In a second experiment small circles about $\frac{1}{8}$ inch diameter were cut from a plate culture of potato agar and placed on the surface of the cap to avoid injury to the skin. Similar pieces of sterile agar were placed on the caps of the other mushrooms to serve as controls. All the mushrooms were covered with cellophane bags to protect them from insects. After six to seven days, the tissue beneath the point inoculated had been turned brown to a depth of about $\frac{1}{4}$ inch. In one case zoning of the brown tissues was observed as in the original specimens. The fungus was again easily reisolated from the brown tissue.

This disease is evidently very rare. No measures of control can at present be recommended except careful removal and destruction of all diseased fruit bodies.

The writer is indebted to Miss E. M. Wakefield of Kew for confirming the identification of the fungus and for information concerning previous records.

4. *Verticillium* Wilt of the Chrysanthemum.

E. OYLER.

Investigation of the wilt disease of chrysanthemums described in this Report for 1937 has been continued.

All chrysanthemum plants received during the year were examined for *Verticillium*. Isolations were made from forty-two different batches and of these six proved to be infected. In addition to the varieties reported last year the fungus has been found in Absolute, Enton Beauty, May Wallace and Roi des Blancs.

Inoculation experiments.

(a) STEM INOCULATIONS.

The stems of eight plants, four Rose Précoce and four Conqueror were inoculated at soil level at the end of June with a pure culture of *Verticillium*. After a month one plant of Rose Précoce was dead and the lower leaves of the remaining seven plants were dead and the leaves at the top of the plants shewed yellow blotches. The symptoms were more severe in Rose Précoce than in Conqueror.

Forty days after inoculation the stems of Rose Précoce shewed a brown discolouration from the base to the tips, extending into the petioles. Isolations made from the base to the tips of the shoots and from the petioles from all four plants all yielded *Verticillium*.

In Conqueror browning of the wood was slight and restricted to the base of the stem. No *Verticillium* was isolated within 6 inches of the tops of the shoots.

(b) SOIL INOCULATIONS.

The disease is usually transmitted through cuttings from infected plants and it was decided to determine whether healthy cuttings could become infected from the soil.

Pure cultures of the fungus were grown on sand with the addition of 1% oatmeal and on oats. These cultures were mixed with baked soil and rooted cuttings were planted in the mixture: two cuttings were planted in each pot and three pots were used for each treatment. No difference could be seen at any stage in their growth between the plants growing in infected soil and those in soil to which sterilized sand and oatmeal and sterilized oats had been added.

After four months one plant from each pot was removed for examination. No discolouration of the wood was seen in any of the specimens. *Verticillium* was re-isolated from one plant grown in the soil mixed with infected oats. Isolations were made from the remaining plants at the end of six months. *Verticillium* was re-isolated from another plant growing in soil mixed with infected oats. Both infected plants were growing in the same pot. Isolations from the rest of the plants growing in infected soil and from the controls were sterile.

The results suggest that it is possible for chrysanthemums to become infected from soil containing *Verticillium* and further experiments using different methods of infecting the soil are being carried out.

Inoculations with *Verticillium* sp.

Chrysanthemum plants were inoculated above soil level with the following species, two plants being used for each species:—

Verticillium sp. from the chrysanthemum.

V. albo-atrum from the tomato.

V. albo-atrum from the rose (culture from Baarn).

V. dahliae (culture from Baarn).

After a month the lower leaves of the plants inoculated with the chrysanthemum strain were dead and the leaves at the top of the plants shewed yellow blotches. Less severe symptoms were shewn by the plants inoculated with the tomato strain of *V. albo-atrum*.

Three months after inoculation the wood of the stems inoculated with the chrysanthemum strain was brown from the base to the flower stalks and the fungus was re-isolated from wood removed at intervals along the whole length of the plants. *V. albo-atrum* was re-isolated from both plants inoculated with the tomato strain to a distance of 5 cm. above the point of inoculation. No fungus was isolated from those inoculated with the rose strain of *V. albo-atrum* or with *V. dahliae*.

Repeated inoculation tests were made with the weaker strains and it was obvious that they had lost their pathogenicity to some extent. The experiments will be repeated when new cultures are available.

Other hosts.

POTATO.—Shoots of twelve plants growing in baked soil were inoculated. After thirteen days yellow blotches began to appear on the lower leaves of the inoculated plants. After two months five shoots were dead and the rest were wilted and yellow. *Verticillium* was re-isolated from ten inoculated plants, the amount of *Verticillium* present varying with the degree of browning in the shoots. The control plants remained healthy.

Six to twelve specimens of a number of ornamental plants were inoculated with *Verticillium* and a similar number used on controls. The results are summarised in Table 1.

Antirrhinum, aster, potato, *Solanum capsicastrum*, stock, sweet pea and tomato are all susceptible to the chrysanthemum strain of *Verticillium*. No infection was obtained with cucumber and Zinnia. All control plants remained healthy.

Table 1.

Host	No. of plants inoculated	No. of plants infected	Symptoms
Antirrhinum ..	12	10	Wilted after 10 days, plants stunted, wood brown.
Aster	12	11	No wilt, wood brown from base of stem to tip.
Potato	12	10	Wilted after 21 days.
<i>Solanum capsicastrum</i>	6	6	Leaves appeared scorched after 22 days and dropped off, wood brown.
Stock... ..	6	6	Wilted after 21 days, wood brown.
Sweet Pea ...	12	12	Wilted after 13 days, wood brown.

The investigation is being continued.

5. Spotting of Rose Petals.

E. OYLER.

"Petal fire" caused by *Botrytis cinerea*, was recorded on roses grown in the open in Austria by Wenzl in 1938, but has not been described previously in this country.

A consignment of roses (*Ophelia*) which had been returned from market was examined at the beginning of October. The outer petals bore on the lower surface numerous circular necrotic spots 2 to 3 mm. in diameter. The lesions were brown in colour with a darker brown margin and the petals were crinkled around the spots. No lesions were present on the inner petals and the damage had been attributed to splashing with disinfectant used in washing down the house.

Isolations made from damaged petals yielded pure cultures of *Botrytis cinerea*. The outer petals of healthy rose buds were removed and the flowers sprayed with a suspension of *Botrytis* spores in sterile water. The buds were incubated in a moist chamber for twenty-four hours, when typical lesions developed on the petals of all the inoculated flowers. Control buds sprayed with sterile water remained healthy.

The experiments were repeated using dry spores dusted onto the petals with a camel hair brush. After twenty-four hours numerous lesions developed on the petals, smaller than those produced by the suspension of spores in water.

When the infected buds were removed to a dry atmosphere the disease spread very slowly; the outer petals became brown and dry and dropped off. The fungus did not spread to the inner petals. If, however, the buds were kept in the moist chamber a general rot resulted.

The varieties Lady Sylvia, Richmond, Roselandia and Talisman were inoculated with *Botrytis* spores and all four varieties were found to be susceptible. On the yellow and pink varieties the spots produced were brown whereas those on the red variety were colourless or water-soaked in appearance.

Botrytis cinerea is the cause of die-back and bud rot of roses. It also exists as a saprophyte on snags and dead wood, on which, under humid conditions, the fungus produces spores. The natural infection of the buds was due to the presence of spores on the petals which germinated under the humid conditions in the packing case. The disease can be controlled by the removal of dead wood and infected snags and by adequate ventilation.

6. Some Flower Diseases.

E. OYLER.

Twenty diseases not previously reported at the Station were recorded during the year and the following notes concern the more important.

Bacterial fasciation of *Crassula* and *Petunia*.

Leafy galls were produced at the base of the stem above soil level, pale green in *Petunia* and red in *Crassula*. The galls were caused by *Pseudomonas fascians*, the disease being transmitted from the soil.

Root rot of *Chrysanthemum*.

Rhizoctonia solani was found in the cuttings. When it attacked the stools, the symptoms were rotting of the roots and wilting of the shoots.

Ink disease of *Iris*.

The leaves and flower stalks bore elongated, purplish black spots. Irregular black patches occurred on the outer scales, while the fleshy scales shewed sunken black spots with a well defined yellowish margin. The centre of the spot appeared as a black crust composed of diseased tissue, mycelium and spores. The disease is caused by the fungus *Mystrosporium adustum*.

Leaf eelworm on Lobelia.

The plants were stunted and the leaves bore numerous small yellowish lesions which later became large and water-soaked in appearance. Finally the infected leaves became brown and dry. The disease was due to *Aphelenchoides olesistus*. *A. olesistus* has not previously been recorded on *L. erinus*.

Non-parasitic disorders.

LOOSE BUD OF HYACINTH. The bud, which could be lifted out from the leaves, was broken off from the stalk just below the inflorescence. This condition is due either to the bulbs becoming too dry at some period during their growth, or to a sudden change in temperature, *e.g.*, when they are moved into the glasshouse. The bud is broken from the stalk and is carried upwards with the leaves. Some varieties are more susceptible to this trouble than others.

Fasciation of rose and forget-me-not.

In the rose the carpels were enlarged and distorted. Short stalks were growing out from them in a ring bearing carpels on which were stamens and sometimes petals.

In the forget-me-not the stems were wide and flattened and the inflorescence axis and flower stalks shortened. As a result the inflorescence appeared as a flat head composed of flowers with very short stalks in the centre, surrounded by a ring of larger flowers on longer stalks.

7. Verticillium Wilt of the Carnation.

H. L. WHITE.

Depth of penetration of contaminated carnation roots.

Contamination of the subsoil has been alleged to be mainly responsible for the reappearance of this disease in carnation beds after removal or steaming of the top soil. Since few soil fungi are found below a depth of 1 foot it has been asserted that this occurs through the contaminated roots penetrating to lower levels. Immediately following the removal of the wires three excavations were made in different parts of a bed of old and diseased plants. The course of the root debris remaining in the soil was traced down to the finest rootlets. The maximum depths to which these penetrated were found to be 1 foot 10 inches, 1 foot 8 inches, and 1 foot 7 inches. These observations will be extended as opportunity permits. Meanwhile it is to be noted that the depths recorded are roughly in agreement with the statements of nurserymen,

and it is therefore reasonable to presume that steaming to a depth of 2 feet, if efficiently carried out, should eradicate the disease from the soil. Much of the steaming hitherto carried out in carnation houses has undoubtedly not been sufficiently comprehensive to justify the view that it would be effective in disease control. Shallow steaming, however efficiently it is carried out, or the mere removal of the top 6—9 inches, is clearly inadequate for disease control and must lead to disappointing results. On the other hand, removal of the top spit to a depth of 6—9 inches and steaming of the underlying soil before replacing that removed by fresh and preferably virgin soil is a procedure that deserves the attention of those nurserymen who have contaminated beds.

Steaming for disease control is a skilled operation requiring constant supervision. Consequently the alternative plan of cutting off the underlying soil by an impermeable "barrage" of cement or lime is one that appeals to growers not familiar with the precautions to be adopted when steaming. The disadvantage of this procedure is that the "barrage" acts as a barrier to drainage, the deleterious effects being illustrated in some experiments with impermeable barriers now in progress. It may, however, be feasible to make a convex surface to the "barrage" layer so that the drainage water runs off the bed.

Finally it must not be overlooked that the elimination of the disease from contaminated beds is only one aspect of the twofold nature of control essential in the case of this disease. All the precautions adopted to rid the glasshouse of the disease will be of no avail if clean stock is not used for propagation and replanting. The importance of this point has been emphasized again during the past season, there being a striking contrast between those varieties planted after special precautions had been taken to procure clean stock and those varieties in which, because of insufficient number of plants or other reasons, the nurseryman had reverted to the old practice of taking cuttings from apparently healthy plants in diseased beds.

Incubation period of the disease in rooted cuttings.

It has been shown that *V. cinerescens* is present in cuttings taken from apparently healthy plants on diseased beds and that these cuttings root without showing signs of disease. In order to obtain a clean stock it has been recommended that these rooted cuttings are grown on in pots for a single generation so that the diseased plants are gradually destroyed without having already infected their neighbours as would have occurred if they were planted in a bed. Excellent

results have been obtained by nurserymen following this procedure which, however, might be modified with considerable saving of time and space if reliable information were available as to the incubation period of the disease in rooted cuttings.

26/1/38. 317 cuttings were taken by a nurseryman from surviving plants of different varieties in a diseased block of three houses and struck in pans in the nursery propagating house.

8/3/38. 293 (92%) of these cuttings had rooted satisfactorily and were potted up in the usual way. Of the remainder 11 (4%) had rotted at the base and 13 (4%) had remained healthy but failed to root.

These plants were critically examined at frequent intervals and isolations were made from every plant that appeared to be unhealthy. *V. cinerescens* was obtained from four plants and the dates on which these plants first wilted were as follows:—

5/5/38.	} Mean = 13/5/38. = 107 ± 4 days after striking of cuttings.
9/5/38.	
14/5/38.	
23/5/38.	

30/8/38. 253 surviving rooted cuttings were cut at soil level, examined closely for lesions and pronounced healthy. The extent of infection, based on the number of surviving cuttings (sterilized soil was not available and wireworms destroyed a number of cuttings that were eliminated from the experiment), was 1.6%, although in the case of cuttings taken during the summer months as many as 15% have been shewn to be contaminated. The lower value agrees, however, with the extent of infection noted on a nursery in a case where the cuttings were known to be from plants in a diseased bed and the possibility of soil infection could reasonably be excluded. In this case $\frac{12}{1000}$ (1.2%) plants proved to be infected. The spread of the disease from even this small number of foci would be sufficient, however, to cause extensive damage during the period of a crop.

In the above experiment a clean stock could have been secured by holding up the replanting of rooted cuttings for as short a period as four months. Confirmation of this result is being sought by repetition of the experiment.

The striking of tops of rooted cuttings broken out in "stopping."

The possibility of obtaining a clean stock from contaminated rooted cuttings by striking the tops broken out in "stopping" was explored in the case of the experiment reported above. 211 tops were struck between 21/4/38 and 11/5/38 but only 141 (67%) rooted and it was obvious that in many cases these would not have made good plants. The extent of infection would have been insufficient to draw conclusions from the absence of infected tops, but this was not of importance for the problem was settled by making isolations from each of the four infected rooted cuttings at 1 inch intervals. In each case *V. cinerescens* was obtained from the internode below the "stop." It is evident, therefore, that the tops broken out in "stopping" are suspect, even if cuttings of this nature could be shewn to grow ultimately into satisfactory plants.

Dip treatment of infected cuttings.

The possibility of dipping the bases of infected cuttings in a fungicide that would destroy the fungus and yet permit rooting has been explored. For this purpose a dye with well-known fungicidal properties--malachite green--was used. The minimal concentration of the dye that inhibited growth of the fungus was first determined in pure culture. Transfers of mycelium were made to the centre of plates poured with agar enriched with Richard's solution and in which the dye was incorporated in different concentrations. Three plates were allotted to each concentration. The results obtained, excluding four plates discarded through the interference of edge contamination, are given in Table 1.

Table 1.

The diameter (mean of three plates in cms. with standard error) of colonies of *Verticillium cinerescens* after 14 days' growth on Richards solution Agar with different concentrations of Malachite Green.

Control	...	1.8 ± 0.7
1 :	100,000,000	1.9 ± 0.4
1 :	50,000,000	1.9 ± 0.2
1 :	10,000,000	1.3 ± 0.4
1 :	5,000,000	0.5
1 :	1,000,000	growth of hyphae just visible under microscope
1 :	500,000	" " " " " "
1 :	100,000	no growth

In a preliminary experiment with healthy cuttings about 50% had rooted after treatment with the dye at a concentration of 1 : 50,000, 158 cuttings from plants adjacent to diseased patches were, therefore, dipped in this concentration overnight and struck in sand. Only 23% rooted and in these roots were emitted at the side of the base and not through the cut surface. Since the dye had failed to penetrate the cutting to a sufficient depth to justify the supposition that it might affect the fungus further experiments along these lines have been discontinued.

8. *Fusarium* Stem Rot of the Carnation.

H. L. WHITE.

Rotting of the stem-base of carnation cuttings on nurseries is frequently associated with infection by *Fusarium*, usually in conjunction with bacteria. Quick rooting has been considered an important factor in avoiding loss of this nature. In order to ascertain the influence of so-called "growth substances" on the incidence of this type of infection two solutions were prepared—alpha-naphthalene acetic acid at a concentration of 40 parts per million and a well-known proprietary product (P.P.) at the strength recommended. The cuttings were dipped in these substances for fifteen hours prior to striking and also in (a) water, (b) potassium sulphate to give a concentration of 300 parts potassium per million, (c) water with 0.1% alcohol, since this had been used to bring the alpha-naphthalene acetic acid into solution. In a parallel series the sand was watered with a suspension of the spores of *F. culmorum*.

17/3/38. 115 cuttings were struck in sand in 60 pots. Three cuttings were struck per pot and three pots were allotted to each treatment. Fourteen days later further treatments carried out daily were instituted, consisting of supplementary watering and additional doses of potassium sulphate, sodium nitrate and potassium nitrate at concentrations of or equivalent to 10 parts potassium per million.

14/4/38. The cuttings were examined and classified on an arbitrary scale from 0 (complete failure to root) to 4 (very strong root development). The relative values, given in Table 1, refer to the means of nine cuttings, save in the case of water where eighteen cuttings were used.

Table 1.

The relative development of roots on cuttings dipped in different solutions before striking and watered with different solutions after striking. The values refer to an arbitrary scale ranging from 0 (no root development) to 4 (very good root development).

(a) Solutions used for dipping cuttings before striking:—						Uninoculated.	Inoculated.
Water	...	...	...	...	...	2.4	2.9
Potassium sulphate (300 p.p.m. potassium)	...	...	...	...	...	3.1	3.0
Alpha naphthalene acetic acid	...	...	...	...	...	3.1	3.2
Water + 0.1% alcohol	...	...	...	...	...	2.6	—
P.P. (see text)	...	...	...	...	...	4.0	—
(b) Solutions used for watering cuttings after striking:—							
Water	...	...	...	...	...	3.7	—
Potassium sulphate (10 p.p.m. potassium)	...	...	...	...	...	1.9	—
Sodium nitrate ($\equiv$ 10 p.p.m. potassium)	...	...	...	...	...	2.3	—
Potassium nitrate (10 p.p.m. potassium)	...	...	...	...	...	2.1	—

The results of the experiment, subjected to the usual method of statistical analysis of the differences by Student's method of "t," are summarized as follows:—

(1) Inoculation of the sand with *Fusarium* spores did not lead to basal rot of the cuttings in this experiment with the exception of a single pot in which all three cuttings shewed a rot from which *Fusarium* was isolated. It is of interest to note that on one occasion the sand dried out temporarily in this pot whereas, so far as is known, no drying out took place in any of the remaining pots.

(2) The cuttings dipped in alpha-naphthalene acetic acid did not show a significant improvement in rooting over those dipped in water, and moreover there was a marked proliferation of the tissues of the stem base associated with splitting of the stem and a tendency to rot. No difference in the extent of this tendency to rot was detected between the cuttings especially exposed to *Fusarium* infection and those that were not, nor could *Fusarium* be isolated from the lesions.

(3) The cuttings dipped in the P.P. solution shewed uniformly good root development, but here also there was a tendency for proliferation of the tissues, splitting of the stem and rot, though not to such a marked extent as with alpha-naphthalene acetic acid.

(4) Supplementary doses of potassium nitrate, sodium nitrate and potassium sulphate depressed root development under the experimental conditions.

(5) On the basis of the arbitrary scale used the variance within pots was appreciably smaller than the variance between pots. This shews that uncontrolled factors were having more effect than the treatments. Since supplementary watering increased, significantly, root development it is probable that the results of the treatments were masked by variation in water content, which was difficult to maintain at a uniform level in the different pots.

9. Anther Smut of the Carnation.

H. L. WHITE.

It has been pointed out previously that the disease is transmitted in cuttings and through the dispersal of smut spores. In order to investigate the mode of infection by smut spores different methods of infection have been tested as follows:—

(1) Drops of a spore suspension placed on to the surface exposed when "stopping" first year pot plants.

(2) Drops of a spore suspension placed on to the surface exposed in cutting bloom of second year pot plants.

(3) Drops of spore suspension in the axils of leaves at different distances from the growing point.

(4) Watering the soil surface of pot plants with a spore suspension.

(5) Standing pot plants in saucers containing a spore suspension.

(6) Potting up young plants in soil mixed with the roots of infected plants.

The plants were placed in a humid atmosphere for forty-eight hours after inoculation. Examination of the spore suspensions used shewed that the spores were viable and that some were beginning to germinate.

The results were as follows:—

(a) Infection was secured by method (1). The falling of a smut spore on to the cut ends of stems left when "stopping" the plant leads, presumably, to the type of plant with shoots on one side infected and on the other clean that has been noted on nurseries.

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(b) No infection was obtained through an unbroken surface or the exposed surface of a relatively old plant.

(c) No infection was obtained through the roots. Since the disease has been virtually eliminated from a nursery solely by selection of disease-free cuttings and without any special treatment of soil, although 70% of the previous crop was smutted and the soil must therefore have been saturated with smut spores, it appears that infection *via* the roots does not take place.

10. Damping-off of Lettuce.

H. L. WHITE.

From "damped-off" lettuce seedlings received from growers from time to time *Rhizoctonia*, *Alternaria* and *Pythium* have been isolated. In the case of one batch of ten seedlings received during the past season *Rhizoctonia* was obtained from six plants and *Alternaria* from four plants.

18/3/38. Seedlings of Cheshunt Early Giant lettuce were inoculated in sets of three by wounding the stem at soil level and placing in contact with the wound mycelium of *Alternaria*, *Pythium*, *Rhizoctonia*, and a culture of *Sclerotinia minor* received from the N.C.T.C. In one series of inoculations the "60" pots containing the seedlings were placed in saucers under bell jars in a glasshouse and in a duplicate series the pots were placed in a moist chamber out of doors, the average daily maximum and minimum temperatures being 23°F. and 15°F. respectively lower in this latter series.

The results, summarized in Table 1, demonstrate clearly that in this experiment parasitism is dependent on factors other than the presence of the fungus, a wound and adequate moisture. The scars upon the stems of the inoculated plants, which were absent from the stems of the uninoculated plants, suggest that initial stages of infection took place and it is possible that the turgidity of the uninjured cells of the stem under saturated moisture conditions prevented the fungi becoming established.

A *Pythium* isolated from a "damped-off" lettuce plant received from a grower was transferred to flasks of sand that had been mixed with 3% oatmeal and sterilized. After fifteen days' growth the cultures were mixed with sifted, baked soil in the proportion of about 6 : 100. Seeds of Sutton's Golden Ball were sown forty-five to a seed tray and three seed trays were

allotted to each treatment. No infection took place but the results, given in Table 2, indicate that neither watering with Cheshunt Compound nor dusting with cuprous oxide has any deleterious effect upon the germination of lettuce seed.

Table 1.

The result of inoculation of wounded lettuce seedlings with different fungi at relatively high and low temperatures, 18/3/38 date of inoculation, 4/4/38 date of final examination.

<i>Inoculum</i> ...	{ av. max. temp. 83°F... av. min. temp. 62°F...	{ av. max. temp. 54°F. av. min. temp. 47°F.
<i>Rhizoctonia</i> ...	Scars on stem ...	Scars on stem. One plant with central strand discoloured.
<i>Alternaria</i> ...	Browning round point of inoculation. Wilt of 3 leaves of one plant.	Browning round point of inoculation. One plant with central strand discoloured.
<i>Pythium</i> (Strain 1)...	No infection ...	No infection.
<i>Pythium</i> (Strain 2)...	Slight browning round point of inoculation ...	{ Plant 1. Slight discolouration of central strand. Plant 2. Browning of stem probably due to contamination with <i>Botrytis</i> . Plant 3. No infection.
<i>Sclerotinia</i> <i>minor</i>	28/3/38 One plant completely destroyed and covered with typical <i>Sclerotinia</i> growth. 4/4/38. Remaining plants not infected.	1/4/38. One plant completely destroyed and covered with typical <i>Sclerotinia</i> growth. 4/4/38. Stems of remaining plants marked with reddish scars.
Control ...	Healthy. No scars upon stem.	Healthy. No scars upon stem.

Table 2.

The mean stand (45 sown) of seedlings per seed tray (with standard error) of Golden Ball Lettuce seed.

	In sterilized soil.	In soil contaminated with <i>Pythium</i> .
No treatment ...	43 ± 0.7	38 ± 4
Watered with Cheshunt Compound ...	37 ± 2	41 ± 0.7
Dusted with cuprous oxide ...	40 ± 0.4	41 ± 0.4

In an experiment with the same treatments as described above soil, suspected of being contaminated with *Rhizoctonia*, was used. A number of lettuce seedlings collapsed from damping-off, and *Rhizoctonia* was obtained from eight out of ten plants used for isolation. The infection did not appear to be influenced by any of the treatments.

The above experiments illustrate clearly the unsatisfactory nature of attempts to control disease by fungicides without an understanding of the principles underlying parasitism. Such an understanding requires physiological investigation of the effects of temperature, moisture and other factors upon both plant and fungus, either by subjecting the results of seasonal repetition of infection experiments to statistical analysis in conjunction with meteorological data or by the less laborious procedure of growing the plants under controlled conditions.

11. A Fruit Rot of Vegetable Marrow.

H. L. WHITE.

During inspection of early vegetable marrows in frames (after removal of the lights) browning of the distal ends of some of the fruits was noted. These fruits appeared distinct from others that were obviously attacked by *Botrytis*. On placing three of these fruits in a moist chamber a white fluffy growth appeared and the marrows were subsequently covered with a thick web resembling illustrations of "Cottony Leak" of cucumber. The fungus has not been definitely identified but in culture resembles *Phytophthora parasitica*. It has been shewn to cause a rapid rot of melons and cucumber fruits but only a slow rotting of tomato fruits. Inoculations of the hypocotyl of seedlings of vegetable marrow, cucumber, melon and tomato failed to result in "damping-off."

The disease resembles Buck Eye Rot of tomato fruits in that infection is presumably derived from the splashing of fungal spores from the soil on to the fruits. This probably occurred during heavy storms about a week previous to the observation of the disease. It is of interest to note that "damping-off" of young tomato plants was prevalent in glasshouses in the vicinity.

12. Virus Diseases.

G. C. AINSWORTH.

(a) General.

The following notes record some of the more interesting observations made on specimens received for examination :—

Tomato,

During the past season more cases of Mixed-virus Streak were recorded than in any one previous year. The disease was noted in Hertfordshire, Guernsey, Norfolk, Anglesea and

Northumberland. In several outbreaks of Mixed-virus Streak noticed in recent years the source of the potato virus component was traced to potatoes growing adjacent to, or among, the tomatoes (see Annual Report for 1935, p. 57), but in no instance during the past season was the origin of the potato virus determined. The potato virus components of the streaks were all strains of potato virus X of medium virulence. The description of Mixed-virus Streak given in the Annual Report for 1934, p. 63, can now be supplemented on one point. The green fruit on a plant affected by Mixed-virus Streak commonly shews irregular superficial, *raised*, brown-coloured markings (similar to those described in America by Vanterpool, 1926), and this symptom is, therefore, one of use in distinguishing Mixed-virus Streak from Single-virus Streak in which the fruit lesions are depressed.

Bushy Stunt, which was not recorded here during 1937, was recorded on one occasion.

An outbreak of "fern leaf," caused by *Cucumber virus 1*, occurred in a crop of winter tomatoes at this Station. The plants in question, which were grown in pots, stood out-of-doors during the late summer and it was, presumably, during this period that they contracted the disease although, apart from an occasional plant, symptoms did not develop until the plants were transferred to the houses. *Cucumber virus 1* is seldom found in tomatoes under glass in this district despite the prevalence of the virus on vegetable marrows and other outdoor plants. The virus is aphid-borne and greenfly are rarely found in large numbers on fruiting tomatoes in commercial glasshouses.

Spotted Wilt was recorded from various localities but this disease is still an uncommon one in the Lea Valley. Two slight aberrant cases were noted. In the first, from a nursery on which Spotted Wilt was recorded the previous year and proved to have originated from a stock of chrysanthemum cuttings, the unripe fruit shewed very severe Spotted Wilt markings but leaf symptoms were very slight owing to the plants having been "stopped," probably about the time of infection, when nearly all immature leaves were removed. In the second case Spotted Wilt bronzing of the leaves was associated with brown streaks on the stem and leaf stalks but only the virus of Spotted Wilt was demonstrated by inoculation tests.

Enation Mosaic was recorded in Essex, a few miles from the locality where the disease was first noticed in 1935.

Gladiolus.

Our attention was drawn to several cases of a mosaic disease affecting gladiolus. The leaves of infected plants shew a more or less pronounced mottle and the plants themselves are somewhat stunted. The flowers may "break," that is to say the flowers of coloured varieties may be disfigured by white streaks. This disease is probably the one noted in America in 1928 (Doddall, *Phytopathology*, XVIII., 215—19, 1928), but nothing appears to be known concerning its host range or method of transmission.

Chrysanthemum.

Specimens of *Chrysanthemums*, var. *Exmouth Crimson*, received from Mr. W. Buddin, shewed a slight but distinct mottling of the upper leaves. The mottle was for the most part confined to shades of green, but on some leaves it tended to yellow. Inoculation tests demonstrated the presence of a strain of *Cucumber virus 1* able to cause much greater distortion in *Nicotiana glutinosa* than the type virus. This appears to be a new host record for *Cucumber virus 1* which has however been recorded previously in *gaillardia*, *aster* and other plants of the family *Compositæ*.

During the season *Cucumber virus 1* was also found infecting tomato (see above), vegetable marrow, lupin, asparagus kale, and sweet pea (the last two plants being new hosts in this country).

(b) Lettuce Mosaic.

The study of lettuce mosaic, of which a progress report appeared last year, was continued in co-operation with L. Ogilvie of the Long Ashton Research Station and, as regards the disease of lettuce, completed.

The transmission of the virus through lettuce seed was confirmed (6·06% of 3,451 seedlings raised from infected seed shewed symptoms of mosaic) and it was found that transmission occurred through both two and three-year-old seed; the percentage transmission being the same as for one-year-old seed. A variety trial was undertaken to determine the susceptibility of different types of cabbage lettuce to mosaic and it was found that although there was no variation in the resistance to infection shewn by any variety (with the possible exception of certain of the Gotte lettuces) some lettuces were much more tolerant to the virus than others. The varieties tested could be grouped into two classes, those which shew mild symptoms and those in which the symptoms are severe. A detailed account of this trial will be published elsewhere and it need only be remarked here that all the

forcing types appear to fall into the severely affected class. This character of forcing lettuces should, however, have little significance for growers because it is in glasshouses and frames that the aphides which spread mosaic can be easily controlled so that, providing virus-free seed is used, lettuce mosaic ought to remain a disease of minor importance under glass.

The host range of the virus was extended to groundsel (*Senecio vulgaris*) and prickly sow thistle (*Sonchus asper*) and to garden and sweet peas. The symptoms in groundsel are very mild and some evidence was obtained that the virus is transmitted through the seed of this plant. Although groundsel is not a perennial overlapping generations occur all the year round so that groundsel must be considered to be a very dangerous weed in lettuce plantings. Garden pea (var. Lincoln) shewed mild mosaic mottling but sweet pea developed symptoms of a streak disease when infected with lettuce mosaic virus.

(c) Virus Diseases of Leguminous Plants.

In order to elucidate the relationship of the virus of lettuce mosaic to the already described viruses affecting leguminous plants a survey of the virus diseases found affecting leguminous plants in this country was begun. This survey, which will be continued next season, has already yielded some interesting results.

Both garden peas and sweet peas have been found infected with lettuce mosaic virus, the latter plants showing streak symptoms.

Two other diseases have been found to occur frequently in peas. The first, enation pea mosaic (described in America by Osborne, *Phytopathology*, XXV., 160—77, 1935), is characterised in sweet pea by a yellow flecking of the leaves and the development of leafy outgrowths, enations, from their under-surface. Similar enations develop on the undersides of garden pea and broad bean leaves. The second, the common pea mosaic (really a group of diseases caused by strains of one virus), attacks garden pea, sweet pea, broad bean and red clover. The strain of the common pea mosaic virus most frequently observed has been one which causes a very mild, almost imperceptible mottle in sweet pea leaves but is responsible for the breaking of coloured flowers. This strain causes very mild mosaic of garden pea but other strains give rise to more intense mosaics in both plants.

Several other viruses have been observed but the study of the group is unfinished.

(d) Viruses of the Cucumber Virus 1 Type from Monocotyledonous Plants.*

In last year's Report (p. 56) mention was made of Lily Mosaic. During the past season similar viruses to the one obtained from lily have been detected in hyacinth and tulip. These three viruses have been studied sufficiently to prove that they are strains of *Cucumber virus 1*, but they all tend to remain localised in the leaves of tobacco and cucumber and thus differ from the type virus which causes systemic infection in these hosts.

* For further details see the illustrated note in Ann. Appl. Biol., XXV., 867—9, 1938.

13. Fungicide Investigations.

W. H. READ.

A number of samples of cuprous oxide have been tried as fungicides for controlling the chief leaf fungi of glasshouse crops. These tests were commenced last year and further trials incorporating several additional samples of cuprous oxide have been made.

Considerable variation was found in the fungicidal activity of the different samples of cuprous oxide when applied at equivalent copper contents, and the differences were more evident when water soluble wetting agents were incorporated in the sprays than when petroleum emulsions were incorporated. Two samples of dispersible cuprous oxides (containing 55% and 48% of copper) were greatly superior to other samples of cuprous oxide which were not readily formed into aqueous suspensions, and large scale trials on glasshouse crops were made with these two. It was found, however, that when the cuprous oxides were applied at an effective fungicidal concentration (0.1% copper in the spray) the deposit on foliage, fruit and flowers was excessive. Many tests were made incorporating various amounts of wetting agents in the spray but effective control of tomato leaf mould (*Cladosporium fulvum*), cucumber mildew (*Erysiphe cichoracearum*) and rose mildew (*Sphaerotheca pannosa*) was unobtainable without the formation of excessively visible deposits. Although the incorporation of oil emulsions with the cuprous oxides enabled a reduction in the amount of the cuprous oxides to the equivalent of 0.05% copper in the spray without loss of fungicidal efficiency, the marking at this concentration of cuprous oxide was more pronounced owing to the uneven distribution of the fungicide than that given by the cuprous oxide sprays (0.10% copper) in the absence of oil emulsions.

Cuprous oxide sprays containing an oil emulsion together with a wetting agent (Agral) were tried but were found to cause too much marking at fungicidal concentration and it is regretted that this promising fungicide appears to be of limited value for the most important glasshouse crops.

A copper-zinc silicate (25% Cu 4% Zn) when used at 0.2% in combination with a petroleum emulsion gave good control of tomato leaf mould without noticeable marking of the foliage or fruit. This combination caused rather more marking of rose foliage than the copper-oxychloride—oil emulsion mixture which has been mentioned in previous reports. The control of tomato leaf mould by 0.2% copper-zinc silicate with a water soluble wetting agent was not effective and left a more readily visible deposit than when used with an oil emulsion.

Tests have been made with a number of proprietary fungicides, several of which contained copper-oxychloride as the active principle. Advantage was gained by using many of these in conjunction with petroleum oil emulsions.

The number of samples of formaldehyde and cresylic acid preparations submitted by members for analysis shews an increase on last year.

All the samples of formaldehyde have conformed with the requirements of the Ministry of Agriculture's specification (Bulletin No. 82).

3. Animal Pests.

1. Rose Thrip (*Thrips fuscipennis*, Hal.)

E. R. SPEYER.

It has been established that the Rose Thrip passes the winter in crevices in the woodwork of glasshouses and in the bark of older rose bushes, and that the insect does not enter the ground. Only adult and fertile females go into hibernation in autumn, but in glasshouses in which heat is kept on during the winter months these may also be found amongst the leaves of young shoots and the petals of flowers, where, however, they do not lay eggs and only feed very sparingly until the middle of February at the earliest. During the hibernating period, which is computed to extend over a period of six weeks to four months, according to temperature, the insects do not become dormant even at temperatures considerably below freezing point, and they are thus able to move from place to place, even taking to flight, in the event of their immediate environment becoming unsuitable owing principally to excess of moisture, to which they are averse.

Out-of-doors this insect was found in greatest numbers in the bark of chestnut, in company with the more numerous females of *Thrips major*, Uzel., and also in that of hawthorn.

Females of *T. sambuci*, Uzel., possibly a variety of *T. fuscipennis*, Hal., were obtained from the bark of a hybrid elder, and both sexes of *Oxythrips ulmifoliorum*, Hal., from that of *Sambucus nigra* during the winter months.

No Rose Thrips could be found in the bark of chestnut towards the end of March, and at the beginning of April females containing eggs ready to be laid were collected from rose shoots in the neighbourhood. With this information in hand, it became apparent that the most likely method of control for this pest under glasshouse conditions lay in the application of an insecticide, with some deterrent property in addition to killing efficiency, at a time when the over-wintered females first invade the young rose shoots for the purpose of laying their eggs. Derris and Pyrethrum powders, used both as dusts and as sprays in conjunction with a spreading agent, suggested themselves.

Owing to the small size and great activity of the adult females, it was found possible to observe the effects of these substances upon only a few individuals at a time. Dusted or sprayed leaves were detached from rose plants, placed in a box, and a few insects dropped upon them. Derris powder was slow in action, three days elapsing before an appreciable percentage of the insects were killed.

Pyrethrum powder (a proprietary dust in which pyrethrum extract is absorbed upon a carrier) produced paralysis in from ten to twenty minutes and a total mortality within two days. In sunlight the lethal action was lost within twenty-four hours, but a deterrent action was observed to persist for a period of at least three, but for less than five, days.

A 1% solution of potash soft-soap was without action, but when nicotine at the rate of 1 part to 500 parts was added total mortality resulted within twenty-four hours, but both lethal and deterrent action was lost entirely within forty-eight hours of application.

With a spray fluid consisting of Derris powder 2 lbs., and soft-soap 10 lbs., to 100 gallons water, total mortality was obtained sometimes within twenty-four hours, but in other experiments a period up to four days elapsed before the majority of insects succumbed: a deterrent action was maintained for a period of four days from the time of application.

At the end of February this latter spray was applied at intervals of four days to twelve pot-plants of roses exposed to infestation by Rose Thrip: a further twelve plants were left unsprayed as controls. Between 14th March and 21st March the sprayed plants produced thirteen blooms, none of which shewed any sign of injury from the insects: the control plants similarly produced thirteen blooms, nine of which were severely injured. The varieties were Sylvia, Roslandia and Los Angeles.

Through the kindness of Mr. Walter Stevens, this spray was applied to the variety Sylvia in a small section of a glass-house in which many insects were already present early in March. Four days after the application numbers of dead females were found upon the shoots, but the foliage assumed a yellowish colour due to the soap solution, so that further spraying was considered inadvisable.

From observations upon the effect of dusting the shoots of plants infested with the insect at the beginning of March, it was concluded that the most likely method of controlling the pest lay in the frequent application of the Pyrethrum powder mentioned above. In the 4-acre block of houses the powder was first applied on 9th March, and the number of successive applications have very kindly been supplied by Mr. Stevens:—

1st Crop.—Seven to eleven applications at four day intervals,
9th March to 16th April.

2nd Crop.—Four applications at intervals of one to two weeks,
20th April to 7th June.

3rd Crop.—Four applications at intervals of one to two weeks,
16th June to 20th July.

1 lb. of powder was used to 100 feet by 20 feet run of house.

The efficacy of this treatment was shewn by the fact that a practically full complement of uninjured bloom was marketed at each crop, whereas during the preceding five years each of the corresponding crops has been an almost total failure through injury from the insects.

Further, the fourth crop in August (which was not marketed) shewed no signs of attack.

There can be little doubt that the treatment should have been started at the end of February, for on 15th March large numbers of larvæ were already present in well-protected positions among the shoots, and this might have enabled a considerable reduction to be made in the number of applications at least to the first crop.

Mr. Ernest Stevens very kindly provided a large number of pot-plants for further experiment with a view to determining the minimum number of applications necessary to control the pest.

At present it may be recommended that the rose-grower who has the pest established in any portion of his nursery should dust the plants four times at intervals of four days, beginning at a time when the first shoots after dormancy have attained a length of about 6 inches. There is little point, however, in starting operations before the middle of February. The powder should be applied lightly so that it falls evenly upon the young shoots from above. Application in bright sunlight is to be avoided as the powder quickly loses its lethal action under such conditions. The plants should be hosed half-way up from the ground, so as to moisten the powder as little as possible and thus to avoid excessive marking of the foliage.

Further investigations into the egg-laying habits of Rose Thrip shewed that the eggs are deposited most frequently within the tissues of the bracts and stalks of young shoots, and of the sepals of flower-buds or opening blooms. They were found less often in the outer petals of opening blooms and only rarely in the leaves of young shoots, never in older foliage or stems,

2. Leaf-miners of Glasshouse Plants.

E. R. SPEYER.

(a) Tomato Leaf-miner (*Phytomyza solani* Macq.).

This insect is referred to on p. 70 of the 22nd Annual Report (1936) under the name *Liriomyza solani*. Tomato leaves containing mines were received from Guernsey C.I. on 6th May, through the British Dye-stuffs Corporation. Adult flies were obtained from this material on 24th May. Through the kindness of Mr. T. Small, of Jersey, more mined foliage with numbers of pupæ in process of emerging to adults was received on 26th May, and a further supply on 16th July. Material from an unknown source in Guernsey came to hand on 7th June, but the pupæ were heavily parasitised by Braconids, and it was therefore not employed for experimental work. The insect was bred upon tomato plants in pots in a glasshouse through three full generations, from the end of May until the middle of August; the first adult flies of each generation emerged from the pupæ on 24th June, 21st July and 17th August respectively, giving the duration of one generation as a full month in early, and only three weeks in later summer. Observations were interrupted in September, but in October many vacated mines were found, and as no further mines occurred after the middle of the latter month it was concluded that the pupæ of the last generation had gone into hibernation in the ground. A single pupa found upon a leaf on 14th October has not yet emerged as an adult.

Though of very small size, the adult flies are conspicuous owing to their shining black head and thorax, marked with bright yellow stripes or dots, and to the iridescent wings. They were found to be very active especially in sunlight, but were seldom seen upon plants in the glasshouse, though known to be present in considerable numbers.

Of thirty-one specimens collected in August, fourteen were males and 17 were females, so that the sexes probably occur in equal proportions. Though considerable numbers of flies were kept together in the laboratory, pairing was never observed. Before or during the deposition of eggs, the flies (probably females only) made pit-marks upon the upper surface, usually of the older leaves of the plants.

Two females kept in confinement upon seedling plants in August were seen to make numerous pit-marks upon leaves near the growing-point. The leaves were preserved, and each female was found to have inserted two eggs into the leaf tissues. The pits containing the eggs did not otherwise differ

from those without them. On staining and mounting the leaves, it was found that each pit-mark consisted of a circular hole, with diameter about 0.1 mm., in the epidermis of the upper surface leading obliquely through the palisade tissue to a spacious cavity (about 0.4 mm. in diameter) in the spongy parenchyma. In the four instances in which eggs were found, these lay in the latter tissue, closely above the epidermis of the lower surface of the leaf. It is concluded, then, that the ovipositor is inserted through the upper epidermis, and that after the palisade tissue and spongy parenchyma have been disrupted, and a large oblique cavity formed in them, the egg is pushed further into the parenchyma. The eggs were white and oval in shape, with an average length of .25 mm. and a breadth at the centre of .15 mm.

Upon plants in the glasshouse, it was noted that the larval mines seldom occurred in leaves upon which numerous pit-marks had been made, and it was apparent that only one egg was deposited in a single leaf, often near the tip, and usually near the edge.

Male flies lived in confinement for a period of about eight days and females for about fourteen days. The period of time occupied by the various stages in the life-cycle of each generation can best be expressed in a log taken from notes of observations :—

May 24th ...	...	Flies emerge from pupæ.	
„ 31st ...	...	Pit-marks on foliage.	
June 2nd ...	...	Beginning of larval mines ...	Emergence to hatching of eggs, 9 days.
„ 7th-12th ...	Larvæ pupate ...	...	Larval stages, 5-6 days.
„ 23rd ...	First pupæ emerge ...	...	Pupal stage about 15 days.
„ 30th ...	Beginning of larval mines ...	...	Emergence to hatching of eggs, 7 days.
July 4th-10th ...	Larvæ pupate...	...	Larval stages, 4-6 days.
„ 22nd-25th ...	Flies emerge from pupæ ...	...	Pupal stage, 14-18 days.
„ 27th ...	Beginning of larval mines ...	...	Emergence to hatching of eggs, 5 days.
„ 30th-Aug. 3rd	Larvæ pupate ...	...	Larval stages, 3-5 days.
Aug. 14th ...	Flies begin to emerge from pupæ ...	...	Pupal stage, 13-16 days.

Though considerable numbers of flies were liberated in the glasshouse between 14th August and 26th August, no new mines appeared upon the foliage up to 1st September. In October it was found that only six mines had been constructed during September upon unsprayed plants; the majority of

plants had been sprayed with nicotine towards the end of August, and, as will be seen later, this evidently resulted in the death of the majority of flies which had been liberated in the house.

During August, plants standing outside became infested, and in October it was evident that a further partial generation had taken place after these were housed in September, and that the pupæ had gone into hibernation—the great majority in the soil.

In all the generations observed it was noted that, irrespective of the age of plants, the majority of larval mines occurred in the leaves of the mid-region of the plants, few being present upon basal branches or upon those near the growing point. The majority of the pit-marks used for feeding purposes by the adult flies, on the other hand, appeared upon the lower leaves.

The larvæ construct the mine by voracious feeding, day and night, while lying on their sides, and their progress is comparatively rapid, for they were occasionally observed to travel a distance of nearly 2 inches in three days. The mine is at first usually straight for a distance of about $\frac{3}{8}$ inch, but later becomes branched and widened through the larva often returning upon its course. In very small leaves the mine is greatly convoluted, but it rarely extends into the leaf-stalk. The larva works at different levels in the parenchyma and palisade tissue, and this sometimes gives the impression of more than one mine in a single leaf: of the many hundreds of mined leaves examined, two mines occurred in one leaf in but two instances.

The very short duration of the larval life is noteworthy, and renders the collection of mined leaves useless as a means of control, especially in view of the fact that only a comparatively small proportion of the leaf-tissue is destroyed by the larva. Further, the mines tend to heal after the larvæ have vacated them in order to pupate.

On becoming full-fed the larva leaves the mine through a slit-like hole—often not easily recognisable—through the under, rarely the upper, side of the leaf, often situated at some point in the mine near the midrib.

In the June and August generations the larvæ, after apparently dropping from the leaves, buried themselves in the soil: some placed upon soil pupated at a depth of about $\frac{1}{4}$ inch. In the July generation the majority of larvæ pupated upon the foliage, stuck, by the posterior extremity to the leaf surface near the exit hole from the mine, by a secretion exuded in the

short prepupal stage. In October only one pupa was found upon a leaf in a total of eighty-three mines. A higher proportion of pupæ kept in moist soil emerged successfully as compared with those kept under dry conditions.

Emergence of the adult flies from the pupæ took place usually at night or in early morning.

Experiments in control.

It was considered possible that the adult flies might be attracted to and killed by a poison-bait spray lightly applied to the foliage. Flies enclosed within large glass vessels with foliage taken from sprayed plants were seen to feed upon such baits containing 0.15%—0.25% sodium silicofluoride, and 2%—2.5% sugar. Of the twenty-one flies used in various experiments, seventeen died within a period of forty-eight hours after enclosure in the vessels: examination of fifteen of the dead insects shewed seven to be males and eight females.

A spray consisting of 0.15% sodium silicofluoride and 2% sugar resulted in the death of all eight flies used in the experiment within a period of two days, and remained effective for at least three days. No injury to the foliage even of very young plants was recorded from the use of this spray, except in one instance when the highest concentration was employed and scorching of foliage in the region of the growing point was noted upon plants 12 inches high.

Owing to the difficulty of determining the exact date upon which the majority of flies are likely to emerge from the pupæ, it was decided that this method of control would not prove practicable upon commercial nurseries. Jar-traps containing beer, treacle, or sugar, to which sodium fluoride was added, failed to attract any flies in a glasshouse in which many flies were liberated.

With a view to preventing flies from laying eggs in the foliage, sprays containing respectively 3 ounces Derris powder and 1 fluid ounce nicotine to 10 gallons 1% soft soap solution were applied to plants 12 inches high, and the number of mines in the foliage counted seven days after the final application: where two applications were given, an interval of twelve days elapsed between each.

It was concluded that these sprays were ineffective in preventing attack by the insect.

The nicotine spray was later thoroughly applied to four leaves each containing a mine in process of construction on 4th July: one larva pupated three days, and the other three five days later, and flies emerged from these pupæ on 23rd July.

Spray	Applications	Plants	Mines constructed
Derris powder	1	6	4
" "	2	5	5
Nicotine 1 : 1,600	1	6	4
" "	2	6	3
Control untreated	—	18	9

A proprietary leaf-miner wash was next tested at dilutions of 1:80 and 1:40. Each set of plants with an untreated control comprised four to six plants 30 inches high, one to three plants 18 inches high, and seven plants 6—9 inches high. The plants were sprayed first on 22nd July, and between that date and 28th July twenty-four flies were liberated in the glasshouse. A second application of the sprays was made six days after the first. The following Table shews the numbers of mines which were collected from the foliage between 27th July, when the first larval mines made their appearance until 6th August, and the total number subsequently obtained:—

Dilution	Mined leaves on August 6th			Total	Total Mines to August 15th
	Large plants	Medium plants	Small plants		
1 : 80... ..	15	3	22	40	45
1 : 40... ..	0	5	11	16	23
Control untreated...	11	4	28	43	54

A marked decrease in the number of eggs deposited in the leaves was therefore obtained with this wash applied at the rate of 1 part to 40 parts water.

It was then decided to test the effects of more concentrated nicotine washes, with the object of preventing the flies from laying their eggs. For this purpose nicotine sulphate sprays of nicotine content respectively 1 : 800 and 1 : 650, with saponin as a spreader at the rate of 4 ounces per 100 gallons water were employed, and also the same proprietary miner-wash as before at a dilution of 1 : 30,

When applied to leaves, the mines of which contained living larvæ on 5th August, the larvæ were not killed by any of the sprays; three days after application respectively fourteen, fifteen, and eleven larvæ pupated successfully, and these pupæ emerged subsequently as adult flies from 21st to 24th August.

Four new mines appeared upon the untreated control plants and six upon those sprayed with nicotine sulphate at the greater dilution from 9th to 15th August, while none were found upon the plants to which the stronger concentration and the proprietary wash had been applied.

The two latter sprays were applied to the majority of plants in the glasshouse towards the end of August and twenty-two flies were liberated.

When examined in October no mines were present upon the foliage of any of the sprayed plants, but on the few plants kept as controls, six mines had been constructed.

It is thought that many flies may have been killed through feeding upon the sprayed leaves prior to laying their eggs, and that this would account for the comparatively few mines upon the untreated control plants. Three flies, of which two at least were females, and which made pit-marks upon the foliage of a young plant with which they were confined in a muslin cage died within a period of three days. In no instance was any injury to the plants, some of which stood but 6 inches high, recorded from the use of these two sprays.

As a control measure it is therefore necessary to use leaf-miner washes at a comparatively strong concentration, and if nicotine is employed, the latter poison should be present in the spray fluid at a dilution of not less than 1 part in 650 parts water. Fortnightly applications are recommended.

(b) Other Leaf-miners.

Chrysanthemum Leaf-miner (*Phytomyza atricornis* Mg.): adult flies bred from *Sonchus* were attracted to the foliage of tomato which had been sprayed with .2% sodium fluosilicate and 2% sugar on 15th June. Three flies enclosed in a vessel with sprayed foliage died within forty-eight hours.

An adult fly of *Phytomyza ranunculi*, Mg., a common leaf-miner of buttercup, was seen to feed on 30th June for less than five minutes upon a leaf dipped in the above spray: less than an hour later the fly was dead. Adults of Carnation leaf-miner (*Delia brunnescens*, Zett.) were similarly attracted to and killed by this poison-bait spray on 4th July.

Trypeta zoe, Mg., was recorded in large numbers from Chrysanthemum plants growing out-of-doors at Cheshunt on 20th June. The mines constructed by the larvæ are far larger and more blister-like than those of *Phytomyza*: several larvæ appear to inhabit a single mine from which the larvæ emerge before pupation.

Larvæ kept under observation pupated from 21st to 23rd June and emerged as adults from 19th to 24th July. Pairing was observed to extend over a period of three days at least.

3. Angle-Shades Moth (*Brotolomia meticulosa*, L.).

E. R. SPEYER.

Caterpillars of this moth have been unusually abundant in glasshouses during the autumn and winter months. They have caused much injury to flowers of Chrysanthemum and to the foliage of Cineraria.

The moths appear to deposit their eggs upon the foliage of Chrysanthemum plants in September, probably before the plants are brought into the houses. The young caterpillars at first remove the epidermis of the leaves, but as soon as the flower buds open they secrete themselves among the petals, upon which they feed at night, causing very severe injury. They are recognisable by their smooth velvety skins, and by the presence usually of a series of oblique markings on the back. Their colour was found to be extremely variable even when they had attained a length of only $\frac{1}{2}$ inch, ranging from almost white or very light green to dark green or brown. The colour of the blooms upon which they had been feeding did not materially influence and certainly was not responsible for this variation. When full-grown the caterpillars attained a length of nearly 2 inches and descended to the ground, wherein they usually spun a cocoon prior to entering the chrysalis stage, which, under laboratory conditions, lasted some seven weeks.

The practice of hand-picking the caterpillars at night as a means of control is extremely laborious and doubtfully effective, and experiments were conducted on a small scale with a view to finding a better remedy. Spraying with lead arsenate can only be resorted to for a comparatively short duration of time after housing the plants: blooms and foliage, however, were sprayed to test the effect of the poison. Using lead arsenate paste at the rate of 1 ounce to the gallon, two caterpillars died on the second day after being placed upon the

flowers: four fresh caterpillars placed upon the flowers two days after application and removed to untreated blooms after a period of two days did not feed upon the latter, and all died during the following seven days. Spraying with lead arsenate paste at the rate of 6 pounds to 100 gallons water can therefore be recommended up to a period of three weeks before the blooms are ready for market. It is probably inadvisable to add a spreader to the spray fluid when applying it to *Chrysanthemum* foliage.

Dusting of flowers with *Pyrethrum* powder and with powders containing nicotine or naphthalene neither killed the caterpillars nor deterred them from destroying the flower petals. Applications of Derris dust prevented feeding for periods up to four days, but did not kill the caterpillars, which proved to be tolerant of prolonged starvation. Further, the powder made the blooms unsightly and was not easy to remove from them. The mineral cryolite, a double fluoride of sodium and aluminium, ground to a fine powder and dusted lightly upon flowers acted as a powerful poison to the caterpillars. Three placed upon dusted flowers on 6th December were all dead by 13th December, and the petals had hardly been noticeably injured by feeding of the caterpillars. When mixtures of 1 part cryolite to 4 parts respectively of ground rice or kaolin were used, caterpillars died within four days, but in both cases much injury had been occasioned to the petals before they succumbed.

It would appear that light dusting of open blooms with finely powdered cryolite unmixed with a filler offers a possible means of destroying the caterpillars in the event of lead arsenate spraying not having been resorted to at an earlier period. The flowers used in the experiments, of the varieties Cheshunt White, Friendly Rival, Thanksgiving, May Wallace, and Red Beauty, shewed no injury from the powder, which is of a far less poisonous nature than lead arsenate, and which was easily removed, where noticeable, from the petals by shaking or blowing.

4. Yellow Underwing Moth

(*Triphæna pronuba*, L.).

E. R. SPEYER.

An epidemic infestation of caterpillars of this moth was recorded in carnation houses near Basingstoke at the end of October. It was stated that some 4,000 caterpillars were collected within a few days and that this made but a small impression. At night the caterpillars, which are brown with

double broken lines of black and yellow markings on each side upon the dorsal surface, climbed the plants from the ground in which they were buried during the daytime and caused widespread defoliation. Caterpillars kept in the laboratory and fed upon knot-grass ceased feeding towards the end of November, and constructed earthen cells some 4 inches below the soil surface but spun no cocoons for themselves: they pupated in these cells in January, and the first moth emerged on 20th February.

The caterpillars were quickly killed when fed upon Carnation plants dusted with Derris powder, and by a poison-bait consisting of bran 28 parts, Paris green 1 part and 5—7% treacle solution to moisten, placed in small heaps upon the soil surface.

5. Carnation Tortrix (*Tortrix pronubana*, Hb.).

E. R. SPEYER.

An illustrated account of this insect was published in the Carnation Year Book for 1938 (pp. 21—30, figs. 1—9). An outbreak of the pest occurred upon Cyclamen and Crassula plants at Enfield in summer and became of a serious nature in the autumn. At this time caterpillars were also found upon Geranium plants at the Experimental Station. On Cyclamen the caterpillars spun adjacent leaves together, rolled up their edges or fed under webs stretched over the upper surfaces of the leaves. Beneath these webs, from which they seldom emerged, they ate large trough-like cavities in the foliage. The caterpillars of the autumn generation fed well into winter, and the first moths emerged from the chrysalids in January. It was noted that the moths of both sexes became active in the presence of sunlight.

Control measures are described by O. B. Orchard on page 77.

6. Onion Thrip (*Thrips tabaci*, Lind.).

E. R. SPEYER.

An interesting case of attack by Onion Thrips upon tomato fruit was recorded from Roxborough, Scotland, in October. In the glasshouse in which the injury occurred, onion plants had been grown in early spring, followed by melons, and finally tomatoes of the varieties James Craig, Clibran's Victory, and Carter's Sunrise were raised in pots

and boxes. Green fruit upon the tomato plants shewed occasional depressed patches, formed of air-filled punctures interspersed with dark excrement. Upon ripening fruit the patches were more numerous and of a lighter colour than the surrounding tissue. The ripe fruit was conspicuously bespeckled with golden fleck-marks, usually more or less confined to the proximal portion, while oval unmarked areas shewed where a fruit had been touching its neighbour on each side: a short distance from the insertion of the calyx there was a complete ring, varying from $\frac{1}{10}$ to nearly $\frac{1}{2}$ inch in breadth on different fruits, of a white colour speckled with dark excrement. Dead adult insects occurred sparingly upon the fruit and in considerable numbers among the sepals and upon the stalks. Foliage shewed only slight fleck-marks, but here living adults were very numerous though no young stages could be found.

Some of the insects were enclosed in vessels with fruit (variety Ailsa Craig) in various stages of ripening taken from plants at the Experimental Station. Two days later, exactly similar markings had been made upon the fruit, the white ring appearing either round the distal or proximal portion, according respectively as to whether the fruit had been placed stalk-end or free-end upwards.

Injury of a similar nature has been noted in the past but hitherto the cause had not been ascertained. The golden fleck-marks and light rings in no way resemble spots caused by *Botrytis*.

7. Aphids in Glasshouses.

E. R. SPEYER.

The Rose Aphis (*Macrosiphum rosae*, L.) was controlled to such an extent by applications of Pyrethrum powder, that fumigation was found unnecessary upon a commercial nursery.

Chrysanthemum Black-fly (*Macrosiphum sanborni*, Gill.) was destroyed upon young plants by a single application of a spray consisting of nicotine (95—98%) 10 fluid ounces, soft-soap 8 pounds, to 100 gallons water.

Arum Green-fly (*Myzus circumflexus*, Buckt.) though fully exposed on foliage was not killed by fumigation with $\frac{1}{4}$ ounce calcium cyanide to 1,000 cubic feet space; all adult of Greenhouse White-fly on Heliotrope and other plants were destroyed during the same fumigation.

8. Mushroom Flies.

E. R. SPEYER.

While experimenting with jar-traps in a small tomato house, it was noted that large numbers of Scatopsid, and some Sciarid flies were caught by baits containing ale and treacle. As these flies are often common, and the larvæ of Sciarids often extremely injurious in mushroom sheds, a few jars were hung above the shelves in the Experimental Station mushroom shed during November and December.

The following Table shews the number of flies found floating in the baits used, over the stated periods of time:—

Period	Composition of Bait	No. of				Scatopse	Phorids
		Jars	Male	Female			
14 days ...	Ale 2 pints, Treacle 1 pint	... 4	... 66	... 28	... 39	... 10	
14 ,, ...	Treacle 33%, Amyl acetate 1%..	4	... 10	... 30	... 3	... 5	
8 ,, ...	,, ,, ,, ,, ,,	2	... 4	... 13	... 1	... 14	
8 ,, ...	Treacle 33%	2	... 10	... 8	... 1	... 52	
8 ,, ...	Ale	2	... 12	... 12	... 2	... 19	
8 ,, ...	Ale with 1% Amyl acetate	2	... 4	... 14	... 1	... 10	

The number of flies in the shed was not great during these preliminary observations, and Scatopsids appeared to have decreased greatly in numbers during the second period.

Some evidence is here provided to the effect that Sciarids are attracted to a mixture of ale and treacle, but Phorids principally to treacle alone. The addition of amyl acetate has the apparent effect of deterring male Sciarids from visiting the baits, but not the females. Some 50% of the latter contained eggs. The position of the jars was changed daily during the observations.

9. Control of the Carnation Tortrix Moth (*Tortrix pronubana*, Hb.) on pot plants.

O. B. ORCHARD.

During the late summer an outbreak of the Carnation Tortrix Moth Caterpillar occurred on a batch of cyclamen plants, and caused extensive damage. A very wide range of flowering plants were in cultivation on the nursery, and it is probable that the pest was introduced on plants imported from other nurseries.

The first obvious sign of the presence of this pest, is the occurrence of rolled leaves or adjacent leaves fixed together by means of a fine silky web. Beneath these webs, the caterpillars feed on the leaf surfaces and only leave them to form new webs when fresh feeding grounds are required. Once the larvæ are sheltered beneath the web it is practically impossible to reach them by a contact insecticide, and the only possible control is by the application of a poisonous substance to the leaf surface. The pest did not make its appearance until the cyclamen plants had commenced to flower, and this made it impossible to spray with any insecticide or dust which would leave a deposit on the foliage and flowers. The plants were sprayed with nicotine at a dilution of 1 in 1,000 with the addition of a wetting agent, but control was not effected.

A concentrated derris insecticide and also nicotine and derris dusts failed to give control, and it was found necessary to resort to hand picking to control the pest.

The caterpillar was found later causing serious damage to an autumn rooted batch of *Crassula coccinea* cuttings by eating the young shoots of the plants.

Complete control of the pest was obtained in this case by spraying with lead arsenate paste. To facilitate the removal of the deposit, the spreading agent was increased to twice the normal strength. About a week after the first application, very few living caterpillars could be found, but a second application was considered advisable. This gave complete control of the pest, and then the plants were occasionally damped overhead by means of a watering can with a fine rose attached. This effectively removed all deposit.

This pest is liable to attack a wide range of pot plants, and in view of the above satisfactory results, spraying with the following mixture is recommended when flowers are absent, and the plants are not about to be placed on the open market:—lead arsenate paste 10 ounces, saponin $\frac{1}{2}$ ounce, water 10 gallons. In cases where the deposit need not be washed off, the saponin should be reduced to $\frac{1}{4}$ ounce in 10 gallons of water.

When the pest occurs on flowering plants, the above spray would damage the flowers, and the most satisfactory means of control in this case would be hand picking.

10. Control of Capsid Bugs on Chrysanthemums.

O. B. ORCHARD.

The Capsid Bug (*Lygus pratensis*, Linn.), known to many growers as the Bishop Fly, has caused extensive damage to chrysanthemums during the past few years and the severity of attack appears to be increasing year by year. All varieties of chrysanthemums are equally liable to attack, and it is not unusual to find some varieties are uninjured on some nurseries, but severely damaged on adjacent sites.

The nature of the damage is well known, the typical symptoms being punctured and deformed foliage, scarred stems, blind shoots and deformed flowers. In severe cases of attack as many as 50% of the blooms may be rendered unfit for market.

Owing to the rapidity with which the insect can move, it is very difficult to control by means of liquids, for when disturbed by the approaching spray the insect rapidly falls to the ground. As the capsid feeds by forcing its proboscis into the tissue it is equally difficult to control by applying any poisonous substance to the foliage.

Although no economic control of the capsid is known, dusting the foliage with flowers of sulphur, as shewn by Speyer in the Fourteenth Annual Report of this Station, is partially effective in preventing extensive attacks, and during the past season experiments have been conducted with three proprietary insecticidal dusts, on chrysanthemums grown at the Research Station, and on two large commercial nurseries. For the purpose of identification these dusts will be known as Nos. 1 to 3.

Dust No. 1 contained sulphur, derris, and nicotine.

Dust No. 2 contained nicotine and derris.

Dust No. 3 consisted mainly of derris.

Dusting was commenced at the end of June on the plants grown at the Research Station, and continued at weekly intervals until two weeks prior to housing the plants. Whenever possible the dusts were applied, by means of a rotary hand bellows, early in the morning while the plants were still moist with dew.

It was not possible to make detailed counts of the number of blooms damaged because the number of plants involved ran into several thousands, and for the purpose of these experiments the results were judged on the quality of the foliage and the number of damaged blooms when gathered for market.

On the Station nursery no control measures were adopted other than the dusts described. The crop was divided into four batches, the particular dust being applied to the same batch throughout the season. One of the four batches was left untreated as a control.

When dusting commenced a great number of capsids were present on the plants, and the foliage was already badly marked and deformed. Towards the end of August it became very difficult to find any of these insects, and when the plants were brought into the houses at the end of September none were detected despite careful search. The damage to the foliage and blooms when cut for market was almost negligible. Unfortunately, both the dusted plants and the controls were equally free of the pest, and it is not possible to claim that freedom from the pest at the end of the season was due entirely to the application of the dusts, but it is considered very probable. After the first three applications of the dusts, there was some evidence to suggest that the capsids were present in fewer numbers where Dust No. 1 had been applied, and experiments on other nurseries confirmed these results.

The above dusts were also applied at intervals of 7—14 days on a very large scale on a commercial nursery. Although the pest was by no means eradicated, the amount of damage was considerably less on these than on the untreated controls. It is also interesting to note that the dust described above as Dust No. 1 appeared to have given the greatest measure of control.

During the third week in July capsid bugs were causing serious damage on another commercial nursery, and in view of the results already obtained at the Station dusting with Dust No. 1 was commenced and continued at 7—14 day intervals throughout the season.

As in the other experiments, a complete control was not obtained as some capsids could be found on the plants throughout the season, but the damage to foliage and flowers was not nearly so extensive at flowering time as during previous seasons.

It is considered probable that these dusts act only as deterrents, because dead insects were seldom found on the plants. During the present season it is proposed to commence dusting operations with the co-operation of interested growers as soon as the chrysanthemum plants are potted and placed in their summer quarters.

Experiments on a large scale have been conducted with a proprietary insecticidal spray containing nicotine. This preparation kills by contact and was found to be highly efficient when applied during periods of sunshine. During sunless weather the capsid bug is rather inactive and feeds under cover of the foliage. Under such conditions the application of a contact spray is useless. During periods of sunshine, the capsid can easily be found feeding on the growing shoots and leaf tips and, under these conditions, application of this insecticide gave very satisfactory control of the pest.

Owing to the rapidity with which the insect moves from the growing shoots and drops to the lower foliage at the approach of the spray, it is suggested that it should be applied through a very fine nozzle, and that the whole leaf surface of the plant should be covered, together with any weeds around the pots. Frequent application is also necessary.

This insecticide is expensive, but the results obtained from these preliminary experiments were so promising that it can be recommended in cases where serious damage is being caused by reason of a heavy infestation of the capsid. The Director of this Station will be pleased to give further information to any interested growers who care to apply to him, as it is hoped that many growers will commence applying this preparation during the present season as soon as potting into the final pots commences.

Very satisfactory control of the capsid bug has been obtained by fumigation with Cyanogas after the plants were brought into the houses. Through the kind co-operation of Mr. C. J. Horwood fumigation experiments were conducted on a very large scale. Soon after the plants were brought into the houses, and before the changed conditions had induced a soft growth, the houses were fumigated with Cyanogas, using $\frac{1}{2}$ ounce per 1,000 cubic feet. Two nights later the fumigation was repeated. No damage was caused to the plants by the two fumigations.

Before fumigation large numbers of the insects were easily found on the plants, but although complete control was not obtained the majority of the insects were killed by the fumigation, and little subsequent injury by the pest was observed.

From the results obtained, it is obvious that nothing less than $\frac{1}{2}$ ounce of Cyanogas per 1,000 cubic feet is effective in killing the capsid bug, for smaller concentrations gave no control. It must be observed however that $\frac{1}{2}$ ounce per 1,000 cubic feet is the maximum dose of Cyanogas that may

be used with safety on chrysanthemums and that higher concentrations cause serious scorching. Further, this concentration may only be used immediately after bringing the plants into the houses, because any soft growth will scorch badly if fumigated at the above concentration.

When capsid bugs are present in large numbers at the time of housing the chrysanthemum plants, growers are recommended to fumigate with Cyanogas, but the above conditions of plant growth and concentrations of Cyanogas must be observed strictly.

11. The use of derris extracts in combination with petroleum oil emulsions.

W. H. READ.

The caterpillars of the tomato moth (*Polia oleracea*) frequently cause loss to tomato growers during the summer when the standard lead arsenate spray cannot be used owing to its poisonous nature. Sprays containing derris as the active insecticide have been used to control the pest on fruiting plants. Since red spider mites often attack the plants at the same time experiments have been made to see if the addition of a derris insecticide to a petroleum (white-oil) emulsion would enable control of red spider mite and tomato moth caterpillar to be achieved with one spray fluid.

The addition of a finely-divided solid to an oil emulsion may have a deleterious effect on the emulsion and therefore a derris extract containing 5% rotenone and 20% derris resins was employed in these trials.

Tomato moth caterpillars of various ages feeding on tomato plants were sprayed with a petroleum emulsion (Grade G, Type S.E.1*) diluted to 1 in 100 to which different amounts of the derris extract had been added. The caterpillars were examined after forty-eight hours to determine the effect of the spray.

The resistance of the caterpillars to the spray increased considerably with their age. Those that had been hatched only a few days were killed by the addition of derris extract equivalent to 0.002% of rotenone in the spray. A rotenone content of 0.0045% in the spray killed all stages with the

* H. Martin. "The Standardisation of Petroleum and Tar Oils as Preparations as Insecticides." (Ann. appl. Biol., 1935, XXII, 334).

exception of some mature caterpillars. The mature caterpillars which are about to pupate, however, shew considerable variation in individual resistance and tests indicated that a rotenone content of 0.007% in the spray was necessary to obtain complete control of all stages of caterpillars.

An investigation of the toxicity to red spider mites of oil emulsions containing derris extract was commenced late in the season. The results obtained shew that a combination of petroleum oil emulsion and derris extract may constitute a spray which will give better control of the red spider mite than those containing derris only, such as the insecticides which are frequently used early in the season when there is risk of œdema following applications of petroleum oil emulsions. It may be possible to employ a safe oil concentration in a combined oil emulsion and derris spray, but investigations must be made early in the season before any definite recommendation can be offered.

12. The Control of Rose Thrips (*Thrips fuscipennis*).

W. H. READ.

Small scale experiments with dusts containing nicotine, derris and pyrethrum were made in 1936 and 1937, and these products were stated (Orchard, Read and Speyer, Annual Report, 1937) to be valueless for the control of thrips on glass-house roses. In these experiments thorough application of the dusts were given to the roses when in full growth and many live thrips were found in the buds and leaf axils a few days afterwards. Furthermore it seemed improbable that dusts could be used because they marked the foliage and interfered with the overhead damping of the plants which is necessary for the production of high quality blooms. Experiments by Speyer shewed that pyrethrum and derris were both toxic to thrips. As a result of this a number of derris and pyrethrum sprays and powders were tried, and finally the grower, by collaborating with workers at this Station, was able to devise a technique for the application of a pyrethrum dust which has enabled him to reduce the damage by thrips to negligible proportions.

Experiments were made in the rose house at the Experimental Station with dusts containing pyrethrum, nicotine and derris.

Owing to the limited number of plants available for these tests only three dusts were used, viz., a nicotine dust (3% nicotine), a derris dust (2.5% rotenone), and a pyrethrum dust the pyrethrin content of which has not been determined.

These were applied to the plants every four days and overhead damping was withheld on the day of application and also that following, whilst on the third and fourth days the plants were sprayed overhead by fitting a fine rose into the end of the hose with the object of washing the dust from the foliage. This treatment was continued from the time of pruning until the calyxes of the flower buds opened. The amount of damage caused was estimated when the blooms had opened.

Owing to the very slight injury by thrips on the untreated plots the results of these tests were not significant although the previous crop had been seriously damaged by this insect. In all cases the blooms on the dusted plants were free from injury.

It is important to note that it was difficult to wash the dusts off plants which had been sprayed previously with a copper oxychloride-petroleum oil mixture for the control of rose mildew and almost impossible to remove them if the fungicidal mixture was applied to unwashed, dusted plants.

A dust combining insecticidal and fungicidal powers that can be easily washed from the leaves should solve the problem.

13. The Control of Red Spider Mite on Carnations.

W. H. READ.

Experiments were made last year with sprays containing dodecyl thiocyanate (Lauryl rhodonate) for the control of red spider mite on carnations and a spray containing 0.17% of this substance was found effective. An account of experiments with a synthetic wax emulsion for the control of red spider mites on carnations was given in the Annual Report for 1936. Comparative trials have been made with these two insecticides. In the absence of a carnation house at the Experimental Station, tests were conducted on pot plants of various ages and varieties, but several carnation growers have co-operated in making trials on their nurseries and we wish to record our thanks for their assistance.

The synthetic wax emulsion consisting of an emulsified solution of chlorinated naphthalene in benzene was used at a dilution of 1 in 160 with the addition of $\frac{1}{8}$ fluid ounce per gallon of Liquid Agral Wetter to assist spreading where the spray was applied through a hand syringe. Where spraying was conducted with motor driven sprayers working at pressures in excess of 50 lbs. per square inch the addition of a spreading agent was found unnecessary. The dodecyl rhodonate emulsion was employed at a concentration equivalent to 0.17% active principle in the spray fluid.

Both substances gave good control of red spider mites including eggs without injury to the foliage except for slight spotting of very soft growth. The petals of open flowers were marked rather more severely by the spray containing chlorinated naphthalene than by that containing dodecyl thiocyanate.

Both substances are the products of the same manufacturers who, for economic reasons have decided to make the chlorinated naphthalene emulsion.

14. Cucumber Root Fly Maggot Investigations.

W. H. READ.

A number of outbreaks of the cucumber root maggot (*Plastosciera perniciosus* and *Pnyxia scabei*) occurred during 1938 causing considerable loss of young plants in pots and mature plants in borders. In most cases satisfactory control of the maggot attacking young plants in pots was obtained when soil was thoroughly drenched with one of the proprietary preparations recommended in previous reports; one being an emulsion of a sulphonated petroleum oil fraction containing 5% of nicotine and the other a tar acid emulsion.

Control of the pest in cucumber beds by these insecticides is unsatisfactory owing to the difficulty of wetting every portion of the compost by watering solutions on the bed. As a rule the maggots do not attack the plants until by feeding on the manure they have reduced it to a slimy paste-like consistency which is very difficult to wet with an insecticide.

"Drying out" the bed is inadvisable as the maggots migrate to the roots for moisture and the severity of the attack is increased.

The tar acid preparation was found to kill 100% of the maggots immersed in it for 100 minutes at a dilution of 1 in 3,000. Control of the pest in a cucumber bed was not obtained when the bed was given eight applications of the same preparation, the first four applications being at a dilution of 1 in 2,000 and the final four at a dilution of 1 in 500. The rate of application to the bed was approximately $1\frac{1}{2}$ gallons per foot run. The plants unattacked by maggots were not seriously injured by this treatment and there is evidence to suggest that a cucumber bed treated with tar acid preparations acquires the ability to decompose these with increasing rapidity.

Many other substances were tested as contact insecticides stomach poisons and fumigants. Preliminary tests were made on pot plants growing in a compost of equal parts of loam and maggot infested rotted horse manure, because tests on maggots in the absence of soil are obviously of little practical value. Very few of the substances tested killed the maggot at concentrations which were harmless to the plants but those which showed promise were tried on maggot infested cucumber beds. None of the stomach poisons tried were of value and no insecticide that could be applied as a drench was better than the tar and acid emulsion. Dichlorobenzene used as a fumigant killed the maggots near the surface but failed to kill those in the interior of the bed.

The control of this pest is a problem of major importance, for attacks which cannot be predicted may cause severe losses in a very short time.

4. Chemical Problems.

1. General.

O. OWEN.

A number of samples of different materials were submitted for examination.

Of the soils examined for general manurial requirements none were of outstanding interest. In general, however, the subject of organic matter appears worthy of mention. Many of the soils handled appear to contain an appreciable amount of organic matter as measured by the loss on ignition. At the same time there is no indication of the presence of "fresh" organic material, and many of the soils are in fact improved by the addition of straw, peat, or stable manure. This raises the question of the comparative value of decomposed and undecomposed organic material. It seems likely that the presence of undecomposed organic material is of great importance on account of its physical effect on the soil particularly as a rooting medium, and it may be that the use of organic material offering a high degree of resistance to decomposition would be beneficial in some of our soils. This effect is of course quite separate and distinct from the benefits that organic matter may confer on a soil in the manurial sense. It is particularly noticeable in the case of very old glasshouse soils which become quite compact despite adequate supplies of lime and apparent adequacy of organic material.

Fewer cases of chlorate injury have been dealt with during the year than has been the case in the past, and it is hoped that the warnings given in previous Reports have caused greater care in the use of weed-killers of this type.

Despite the comparatively low rainfall of the early spring only one sample of water submitted was found to be seriously contaminated with salt. Several enquiries have been made concerning the use of water softeners for nursery work. A number of water samples have been found to be very hard and would be unsuitable for industrial work and probably undesirable for domestic use. There is however no evidence that hardness in the water is detrimental to many plants under glass and for this purpose it does not appear that any method of water softening is likely to be beneficial. The only objection is that with increase in hardness of water there is an increasing likelihood of tomato fruit being marked when splashed during

watering. Such marking is easily removed by wiping during packing and leaves the fruit unblemished. On the other hand hard water increases the tendency to fur and scale formation in boilers and pipes, and for this purpose soft water is advisable.

It is interesting to note that one carnation grower whose soil contained an adequate supply of lime ceased applying it for a time on the assumption that the hard water used would maintain the lime status of the soil. During the comparatively short period of trial it appears that the experiment justified this procedure.

Of the fertilisers examined, a suspected sample of sulphate of potash was found to be well below the usual specification and appeared to consist of a mixture of potash salts. A sample of bone meal of rather unusual colour and appearance was found to be well up to specification. Samples of cotton refuse, sisal and coconut fibre were of low manurial content; samples of meat meal and hoof and horn suspected to be causing injury to plants were found to be completely innocuous.

2. Cleansing Chlorate-contaminated Pots.

As has been reported in previous Reports the use of chlorate weed-killers has been the cause of extensive injury to a wide range of plants raised and grown under glass. A serious feature of such damage is the contamination of pots which appear to retain chlorate for long periods. Washing with brushes and immersion in cold running water is at best uncertain, and at worst useless, and it seemed desirable that a certain and economic method of cleaning should be sought. To this end a number of solutions have been tried. For badly contaminated pots immersion for two hours in boiling water often appears to be effective. It seemed however that a cold solution in which the pots could be soaked was preferable. Of a number of substances tested, the most promising were ferrous sulphate, potassium metabi-sulphite, potassium sulphite and "hypo."

These were tried at various concentrations, and of these the most effective proved to be a 5% solution of photographic hypo. Pots were soaked in this solution for two hours and then rinsed with cold water. After this treatment the pots produced no injurious effects, either from the chlorate or from the "hypo" on plants subsequently potted,

3. Loss of Nitrogen from Tomato Soil.

Attempts have been made to determine the amount of ammonia evolved at the surface of the soil. It will be recalled that in a manure heap under preparation for mushroom beds it was found that ammonia was evolved at the surface of the heap only and it was thought that the same might prove true for soil. A large number of determinations have been made on the ammonia evolved in this way and also from below the surface. In no case was it found in appreciable amounts and even over twenty-four hours the amount was minute compared with the large amount of nitrate which is known to disappear in the soil under some conditions. It is not claimed that the methods of sampling were by any means perfect, but it is felt that if ammonia lost in this way was appreciable some such indication would have been found.

In addition, determinations of the composition of the soil air have been made at various times, but the results obtained have not been sufficiently consistent to justify any conclusion.

5. Miscellaneous:

1. Experiments on the Vernalisation of Tomato Seeds.

D. W. GOODALL AND B. D. BOLAS.

The vernalisation of cereals has been practised successfully for some years and has been used to obtain crops in latitudes where the season is too short for the flowering of plants from unvernalsed seed. Vernalisation as usually practised consists in the chilling of moist seeds after germination has commenced. This causes the cereals to flower after the production of fewer green leaves and at an earlier date.

It is obvious that if the time elapsing between growing and cropping in a plant such as the tomato could be shortened it would be of advantage to the commercial grower in view of the higher price obtainable for early fruit.

Little work appears to have been done on the vernalisation of tomato seed, although two references to some experiments at Leeds appear in the *Gardeners' Chronicle* (I. and II.). In one of these articles a method of vernalisation is given which met with considerable success. The authors kept the germinated seed at 31.5°F. (= - 0.3°C.) for 12 and 24 days before sowing. The resulting plants flowered some two weeks earlier, and gave about 1½ lbs. of fruit more than the controls.

In view of the potential importance of these results to the glasshouse industry an attempt was made to repeat these experiments at Cheshunt, and in addition various other treatments were tried. Seeds (Potentate) were germinated at various temperatures and transferred to a temperature of 0°C. as soon as the radicle has emerged. They were kept at 0°C. for 0—20 days and then sown. This treatment proved too drastic as nearly all the plants were killed. Those used at Cheshunt, unlike those grown at Leeds, were unable to withstand a temperature as low as 0°C., possible because of the different variety (Potentate as against Ailsa Craig) or because the chilling took place at a slightly different germination stage. Therefore, in a second experiment rather less drastic chilling was employed.

Moist seeds were kept at 10°C., 20°C. and 30°C., for periods which had previously been determined as requisite for germination at these temperatures, and another series were kept at

10°C., 20°C. and 30°C. for half these respective periods before chilling. Two chilling temperatures were used (1°C. and 5°C.) and two durations of this treatment (10 and 20 days). In addition moist seeds were kept at 20°C., 25°C., 30°C. 35°C. and 40°C., and sown without chilling for purposes of comparison. The twenty-three treatments were so arranged that all the seeds could be sown on April 8th, 1938. Care was taken to equalise by randomisation the effect of local differences in soil and climatic conditions. A detailed record of the morphology, growth and crop of each plant was kept. Only a small part of these results are discussed in this paper.

Table 1 gives some indication of the effect of the various treatments on the growth rate of the seedling immediately after germination. It will be seen that the time of emergence of the seedling—namely, the time taken for the seedling to penetrate the layer of soil with which it is covered in the seedbox—becomes longer with increases in germination temperature above 20°C. Chilling also increases the time necessary for emergence. This suggests that chilling after germination and high germination temperatures both decrease the growth rate.

The number of leaves formed before the first flower truss (table 2) may be taken as an index of the effect of the various treatments on relative leaf and flower development, and it will be seen that the chilling treatments tend to retard the formation of flowers, the reverse of the effect found in cereals. This effect is more marked if germination has run its full course before chilling.

In Tables 3 and 4 are given some particulars of cropping. Table 3 gives the crop up to 15 weeks from the date of emergence, that is, in most batches, for the first two weeks of cropping. As climatic conditions at particular stages of growth affect the time of first cropping a correction has been made for date of emergence. The correction was $b(\bar{x} - x) + 10$ where the symbols have the meaning used by R. A. Fisher.

Chilling has, on the whole, reduced the early crop, the effect being more marked at 5°C. than at 1°C. Both in the chilled and the unchilled series the largest early crop was obtained by germination at 20°C.; reduction in this crop with high germination temperatures is particularly striking.

Table 4 gives the figures for the total crop gathered. In this table the differences observed in the early crop have become less marked. One interesting feature is that the plants germinated at 10°C. have given the largest total crop.

It will be seen that the effect of chilling after the seed has been kept under germination conditions for some days has on the whole been unfavourable both to growth and fruiting. In this respect the tomato behaves unlike a cereal.

Two other isolated experiments however have indicated a promising line for future work. In both of these the moist seed was chilled before exposure to germination temperatures. In the first case the chilling was at 0°C. for 67 days, and germination at 25°C. (Treatment A). In the second the moist seed was kept at 1°C. for 49 days and germinated at 20°C. for 10 days without further addition of water; this resulted in a partial drying (Treatment B). Owing to unforeseen circumstances no control seeds were available for sowing at the same time as Treatment B, but seeds germinated at 20°C. were sown both a few days before and shortly after; accordingly the figures given for the control below are the result of intrapolation. The crop is in Dgms. per plant.

	Control	Treatment A	Control	Treatment B
Days from sowing to emergence	5.1	6.3	—	—
Leaves before 1st truss	9.75	9.71	10.74	11.73
Crop for 15 weeks	9.7	11.8	2.0	10.5
Total crop	98.7	108.6	115.0	118.3

It is evident from these figures that chilling before germination does not have the same harmful effects as chilling after germination; moreover the increase in the early crop in Treatment B was found to be highly significant. This is the more surprising as the flower truss appears significantly later. These two facts would seem to indicate greater growth rate in the early stages.

Experiments along the lines suggested by these results are in progress.

References:—

- I. *Gardeners' Chronicle* 98. 2547. October, 1935.
- II. *Gardeners' Chronicle* 101. 2610. January, 1937.

[See following pages for Tables 1, 2, 3 and 4.]

Table 1.
Mean Days from Sowing to Emergence.

Germination Temp.	Unchilled		Full Germination Time.		20 days' chilling.	
	10 days' chilling.	5°C.	1°C.	5°C.	1°C.	5°C.
20°C. ...	5.3	—	—	—	10.4	8.3
25°C. ...	5.1	7.3	7.3	5.3	No germination	7.5
30°C. ...	9.1	12.3	12.3	11.6	11.3	8.8
35°C. ...	10.0					
40°C. ...	17.9					
Germination Temp.	Half Germination Time.		Full Germination Time.		20 days' chilling.	
	10 days' chilling.	5°C.	1°C.	5°C.	1°C.	5°C.
10°C. ...	—	9.4	—	—	10.0	8.9
20°C. ...	—	—	—	—	11.0	10.0
30°C. ...	—	—	—	—	10.8	9.8

Mean number of plants in each treatment = 18
Mean standard error of values tabulated = .739

Table 2.

Mean Number of Leaves before 1st Flower Truss.

Germination Temp.	Unchilled		Full Germination Time.		20 days' chilling.	
	10 days' chilling.		10 days' chilling.		20 days' chilling.	
Germination Temp.	1°C.	5°C.	Germination Temp.	1°C.	5°C.	Germination Temp.
10°C. ...	—	—	10°C. ...	10.21	10.61	10°C. ...
20°C. ...	10.75	10.06	20°C. ...	—	10.62	20°C. ...
30°C. ...	10.50	11.33	30°C. ...	10.63	10.50	30°C. ...
25°C. ...	9.75					
30°C. ...	10.25					
35°C. ...	9.65					
40°C. ...	10.50					

Germination Temp.	Half Germination Time.		20 days' chilling.		20 days' chilling.	
	10 days' chilling.		10 days' chilling.		20 days' chilling.	
Germination Temp.	1°C.	5°C.	Germination Temp.	1°C.	5°C.	Germination Temp.
10°C. ...	10.11	10.44	10°C. ...	9.93	10.33	10°C. ...
20°C. ...	—	—	20°C. ...	10.16	10.35	20°C. ...
30°C. ...	—	—	30°C. ...	10.07	10.35	30°C. ...

Mean number of plants in each treatment = 15
Mean standard error of values tabulated = .241

Table 3.

Mean Crop per Plant in 15 weeks (Gm. $\times$ 10). (Corrected for emergence date.)

Germination Temp.	Unchilled		Full Germination Time.		20 days' chilling.	
	10 days' chilling.		10 days' chilling.		10 days' chilling.	
Germination Temp.	10°C. ...	5°C.	Germination Temp.	1°C.	5°C.	Germination Temp.
20°C. ...	22.9	—	10°C. ...	—	13.1	10°C. ...
25°C. ...	19.7	22.6	20°C. ...	17.0	15.6	20°C. ...
30°C. ...	18.3	3.0	30°C. ...	5.8	17.6	30°C. ...
35°C. ...	9.0					
40°C. ...	9.2					

Germination Temp.	Half Germination Time.		20 days' chilling.	
	10 days' chilling.		20 days' chilling.	
Germination Temp.	1°C.	5°C.	Germination Temp.	1°C.
10°C. ...	18.9	12.8	10°C. ...	11.3
20°C. ...	—	—	20°C. ...	26.6
30°C. ...	—	—	30°C. ...	18.7

Mean number of plants in each treatment = 8

Mean standard error of values tabulated = 3.263

Table 4.

Mean Total Crop (Gm. $\times$ 10) per Plant

Full Germination Time.

10 days' chilling.

20 days' chilling.

Unchilled

Germination Temp.	
20°C. ...	113.4
25°C. ...	98.7
30°C. ...	115.6
35°C. ...	139.9
40°C. ...	54.6

Germination Temp.	1°C.	5°C.
10°C. ...	—	—
20°C. ...	141.2	114.1
30°C. ...	67.7	82.2

Germination Temp.	1°C.	5°C.
10°C. ...	86.1	103.7
20°C. ...	—	96.9
30°C. ...	90.0	82.9

Half Germination Time.

10 days' chilling.

20 days' chilling.

Germination Temp.	1°C.	5°C.
10°C. ...	116.8	124.0
20°C. ...	—	—
30°C. ...	—	—

Germination Temp.	1°C.	5°C.
10°C. ...	103.3	176.6
20°C. ...	101.5	76.4
30°C. ...	92.3	99.4

Mean number of plants in each treatment = 8

Mean standard error of values tabulated = 30.59

2. The use of Plant Hormones in the Propagation of Carnations.

O. B. ORCHARD.

Plant hormones are complex organic substances formed in plants which regulate their vital activities. The substances employed in these experiments are frequently termed rooting hormones because they have the power of stimulating the formation of roots.

Many investigators have studied these substances with the result that root-forming compounds have been synthesised and are sold as solutions for use by plant propagators.

By means of these substances it is possible to induce some plants to form roots at any part of the stem, and in such cases roots can be made to develop as freely from an "internodal" cutting as from one cut to a "node." Further, the rate of root formation is greatly accelerated and roots are produced in greater numbers.

The effect of treating cuttings with hormones is very much greater with some species and varieties of plants than others. In a few instances, cuttings of plants which cannot be induced to root under normal treatment do so readily when treated with hormones. In some cases, however, root formation is not affected, and no benefit results from such treatment.

During the past few years the use of plant hormones as an aid to the propagation of cuttings has become an established practice on many nurseries in this country, and most propagators of plants agree that by their use cuttings of hard wooded plants can be induced to root much more readily, that the percentage "strike" is greater, and that the period of propagation may be extended because the type of cutting is rendered of less importance.

In general, it has been found that the only benefit obtained from the treatment of soft wooded types of plants, such as carnations and chrysanthemums which normally root quite readily, is that the propagation period is shortened, and that early root development is much accelerated.

A number of commercial growers who have treated carnation cuttings with hormones have reported that although root production is increased in the propagation stage, there is a suspected tendency for rooted cuttings to die off after potting. A number of such rooted cuttings have been received from growers and examined in this laboratory, and although

fungi and bacteria have been isolated from the decayed areas present at the base of the cuttings, in the majority of cases it has not been possible to isolate a pathogen. It was found that the decayed portion occurs immediately at the base of the cutting, and that roots do not develop from it in the normal manner, but arise from the stem immediately above. In a number of cases this decay has been reported to persist after potting, and to have caused the loss of many plants.

The experiments referred to in this Report were not commenced until the middle of April and must be considered as a preliminary attempt to determine if the use of hormones has a tendency to cause basal rot of carnation cuttings.

Through the kindness of Mr. C. J. Horwood, of Basingstoke, 360 cuttings comprising six varieties were received during the middle of April. Four different composts were used, as it was considered possible that the rooting medium might have some effect on the injury, and also to ascertain if the use of hormones enabled carnation cuttings to be rooted in mixtures less suitable than those usually employed. The following mixtures were used:—Sand; 50% sand and 50% peat; 50% maiden loam and 50% sand.

Growers who have reported the suspected injury to cuttings have employed proprietary preparations of hormones, and on this account it was decided to use two well-known proprietary preparations for the purpose of these experiments.

All the cuttings were rooted by placing them round the sides of size 60 pots, filled with compost.

In one treatment the cuttings treated with hormones were stood in the solutions for the number of hours suggested by the respective manufacturers, while in the other treatment cuttings were inserted in the pots and the solutions watered on to the compost. With both methods the solutions were diluted to the strengths recommended by the makers.

It has been shewn by many workers that by the use of plant hormones root formation may be induced from any part of the stem, and therefore it is claimed that when preparing cuttings it is not necessary to make a cut immediately beneath a node, but that "internode" cuttings root as readily as "nodal" cuttings. As it was considered possible that the type of cutting might have a bearing on any subsequent basal decay, half the cuttings were prepared as "nodal" and half as "internodal" cuttings in all experiments.

The results of the experiments may be summarised as follows:—In all treatments the number of control cuttings rooted was poor. As many as 75% were rooted when sand

was the medium and 33% when sand and loam was used. In all experiments with the hormone-treated cuttings approximately 98% rooted, the results being equally good whether the cuttings were dipped in the solution or whether the solution was watered on to the compost after inserting the cuttings.

The number of treated cuttings which rooted was practically the same irrespective of the type of cutting used. When the cuttings were treated with hormones the rooting medium was of less importance than with the untreated cuttings, as in this experiment the percentage of cuttings rooted was the same in all composts employed.

Root development was very much greater and more rapid where the cuttings were treated with hormones than with the untreated cuttings.

At the time of potting into size 60 pots no evidence was found to suggest that treatment with hormones had caused any injury or decay at the base of the cuttings, but a few weeks after potting a number of plants died, and examination shewed that the majority of them were attacked by the cucumber root fly maggot. As no sign of decay was found when potting it is probable that the root fly maggot was the cause of the failure.

Since these experiments were conducted other workers have shewn that indifferent rooting frequently occurs with cuttings of many species of plants when the hormone solution is used at strengths varying from the maker's recommendations, and experiments are now being conducted with carnations to determine if decay at the base of the cutting is actually due to unsuitable strengths of the solution.

In the experiments described above two of the varieties of carnation used, namely, Laddie and Wivelsfield Crimson, are notably difficult to propagate successfully, but after treatment with hormones no difficulty was experienced.

APPENDIX A.

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Manurial Treatment in Tomato Experiments.

(1) Lime.

All houses received ground caustic lime at the rate of 2 tons per acre.

(2) Stable Manure.

Houses 1 to 5, 7, 8 to 12 received 15 tons horse manure per acre, except plots 1, 2, 3, 11 and 12, house 4.

(3) Base-dressing.

Houses 1 to 12 received $1\frac{1}{2}$ tons per acre of the following mixture :—

- 1 part bone meal.
- 1 part bone flour.
- 1 part hoof and horn.
- 1 part sulphate of potash.

(4) Top-dressing.

SULPHATE OF POTASH.—All houses received a first top-dressing of sulphate of potash at the rate of 2-ozs. per square yard.

FERTILISER MIXTURE.—All houses except plots 1, 2, 3 and 10, 11 and 12, house 4 received 2-ozs. per square yard of the following mixture every fourteen days at discretion :—

- 3 parts sulphate of ammonia.
- 2 parts dried blood.
- 7 parts 30% superphosphate.
- 5 parts pure dissolved bones.
- $\frac{1}{2}$ part bone flour.
- $2\frac{1}{2}$ parts sulphate of potash.

All houses received three top-dressings of the following mixture at the rate of 2-ozs. per square yard :—

- 1 part sulphate of ammonia.
- 1 part nitrate of potash.
- 3 parts superphosphate.
- 5 parts dried blood.

APPENDIX C.

Manures applied to Plots 1-3, and 10-12 in Tomato House 4.

Plot.	TITLE.	Base Manure in Lbs. per sq. yd.				* Top-dressing in Lbs. per sq. yd.			
		Lime.	Stable Manure.	Basic Slag.	Sulphate of Potash.	Super- phosphate.	Sulph. of Ammonia.	Nitrate of Soda.	Sulph. of Potash.
1	Complete Artificials (I.) without Nitrogen	1.0	—	0.4	0.1	0.5	—	—	0.2
2	Unmanured	1.0	—	—	—	—	—	—	—
3	Complete Artificials	1.0	—	0.4	0.1	0.5	0.2	0.2	0.2
10	Complete Artificials with Dung	1.0	7	0.4	0.1	0.5	0.2	0.2	0.2
11	Complete Artificials without Phosphates	1.0	—	—	0.1	—	0.2	0.2	0.2
12	Complete Artificials without Potash	1.0	—	0.4	—	0.5	0.2	0.2	—

* The Top-dressing was applied in eight equal instalments.

APPENDIX D.

Dates of Cultural Operations, 1937—1938.

Crop.	Sown.	Potted into 60's.	Potted into 32's.	Planted out in borders.	First Mulching.	First Top Dressing.	First Fruit Picked.	Last Fruit Picked.
Cucumbers ...	Dec. 29 1937	—	Jan 26 1938	Feb. 19 1938	Mar. 24 1938	April 2 1938	Mar. 18 1938	Sept. 9 1938
Tomatoes ...	Dec. 29 1937	Jan. 19 1938	—	Mar. 11 1938	—	May 4 1938	May 17 1938	Oct. 18 1938

APPENDIX E.

Meteorological Records, 1938.

Month.	Air Temperatures						Grass Temp.		Rainfall			Soil Tem- peratures		Hygrometer				Bright Sunshine		Baro- meter		
	Mean			Absolute			Av. Min.	Absolute Min.		No. of Days P. in.	Greatest Fall	Mean Tem- peratures		Dry Bulb	Depres. of Wet Bulb	Relative Humidity %	Dew Point	Total Daily No. of Aver- Hrs. age.				
	Max.	Min.	°F.	Date	°F.	Date		1 ft.	2 ft.													
January	48.8	36.3	57.0	{ 21st 22nd	28.0	8th	31.6	24.0	10th	2.24	Ins.	Ins.	°F.	°F.	°F.	44.0	2.2	84.2	39.3	40.2	1.3	29.88
February	48.2	35.7	58.0	26th	25.0	24th	31.4	24.0	22nd	0.80	7	0.32	26th	39.8	41.2	31.4	2.5	81.3	38.3	57.5	2.1	30.25
March	60.3	38.4	68.0	20th	28.0	3rd	33.0	22.0	3rd	0.60	3	0.30	24th	43.5	43.8	52.5	3.3	83.3	45.8	124.5	4.0	30.28
April	56.9	35.3	67.0	1st	28.0	10th	29.8	24.0	{ 3rd 18th	0.20	6	0.10	30th	48.0	48.0	50.4	3.1	78.5	43.6	80.0	2.7	30.37
May	61.2	40.9	74.0	12th	27.0	{ 7th 8th	35.0	23.0	{ 7th 8th	1.63	11	0.75	28th	52.5	52.1	54.9	5.8	67.6	43.9	212.2	7.1	29.94
June	71.7	50.0	80.0	21st	42.0	{ 2nd 30th	46.2	37.5	30th	0.23	6	0.12	1st	62.0	60.6	65.0	6.0	61.0	50.8	243.2	8.1	30.07
July	73.0	50.0	83.0	31st	43.0	1st	48.8	39.0	1st	1.66	10	0.72	5th	62.8	62.0	65.0	5.1	67.0	54.6	186.0	6.0	29.90
August	76.0	51.5	86.0	1st	37.0	30th	49.0	35.0	30th	1.02	9	0.35	7th	63.7	63.4	65.0	4.2	77.0	57.0	158.0	5.3	30.30
September	69.0	48.0	81.0	23rd	36.0	1st	45.8	33.5	1st	4.97	10	0.40	24th	58.3	58.7	61.0	4.5	76.0	52.0	137.5	4.6	30.20
October	58.7	42.4	67.0	22nd	28.5	24th	39.2	28.0	24th	3.32	14	0.90	3rd	55.2	52.5	53.2	3.9	76.0	46.1	111.5	3.6	30.00
November	53.9	42.4	71.0	5th	27.0	26th	39.5	24.0	26th	3.32	13	1.13	25th	51.0	48.2	50.6	2.2	85.2	46.2	53.0	1.8	29.84
December	47.6	34.5	55.0	12th	19.0	{ 20th 21st	32.1	17.0	20th	3.31	15	0.55	16th	33.0	43.3	41.0	1.1	91.2	38.1	38.3	1.2	29.81

Total rain for year, 23.3 ins.

No. of days precipitation, 117.

Total bright sunshine for year, 1441.9 hours.

DIAGRAM SHEWING ARRANGEMENT OF EXPERIMENTAL PLOTS, 1938.

